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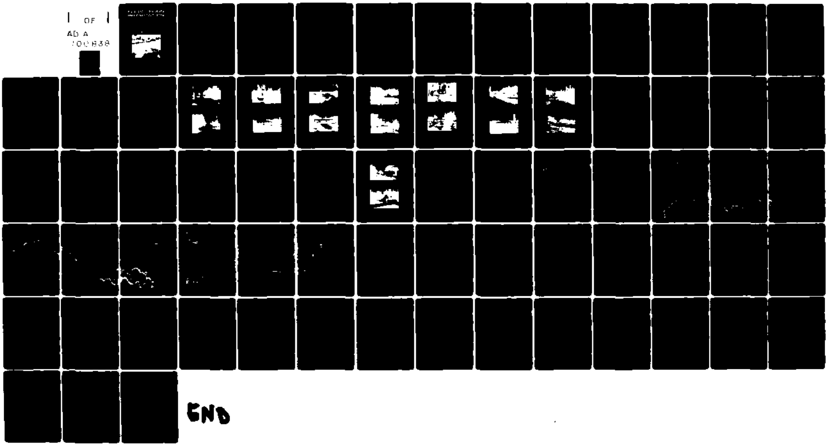

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FLOOD PLAIN INFORMATION

EAST BRANCH CHAGRIN RIVER

LAKE AND GEAUGA COUNTIES, OHIO

PREPARED FOR
OHIO DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WATER
BY
DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
BUFFALO DISTRICT
JULY 1976

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

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This report has been prepared because a knowledge of flood potential and flood hazards is important in land use planning of flood plains. It includes a history of flooding along the East Branch Of the Chagrin River and identifies those areas that are subject to possible future floods. Special emphasis is given to these floods through maps, photographs, profiles, acnd cross sections. This report does not provide solutions to flood problems; however, it does furnish a suitable basis for the adoption of land use controls to guide flood plain development and thereby prevent intensification of the loss problems.

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Debris deposited by storm of June 1959, at the upstream face of the state route 306 bridge over the East Branch of the Chagrin River at Kirkland, Ohio. Photo courtesy Mrs. C. C. Simpson.

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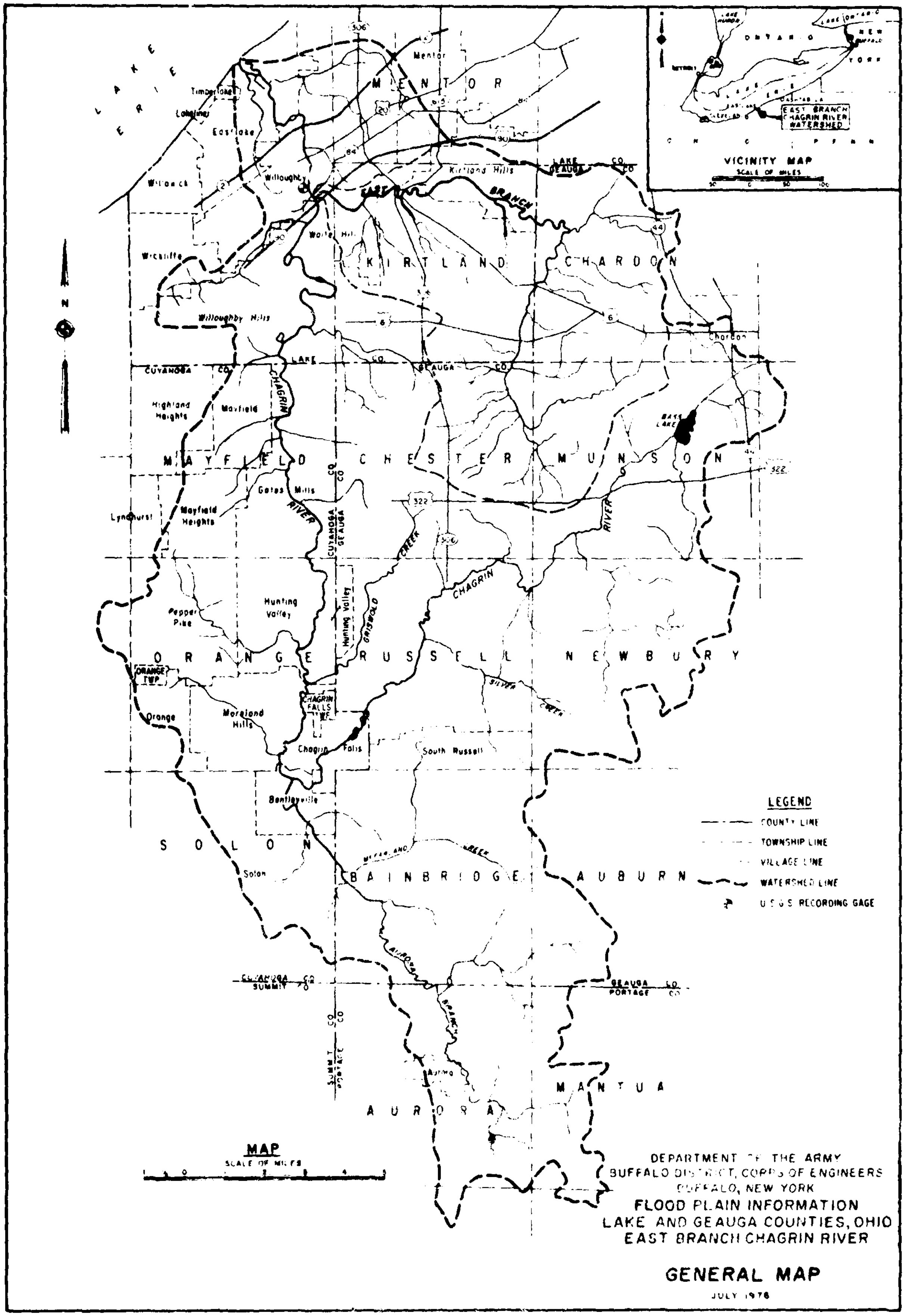
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Timberlake
Lakeline
Eastlake
Willoughby
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Kirtland Hills
LAKE CO
GEAUGA CO
EAST BRANCH
Waite Hill
Wickliffe
KIRTLAND
CHARDON
Chardon
Willoughby Hills
LAKE CO
GEAUGA CO
CUYAHOGA CO
CHAGRIN
Highland Heights
Mayfield
MAYFIELD
CHESTER
MUNSON
Bass Lake
Gates Mills
RIVER
Lyndhurst
Mayfield Heights
CUYAHOGA CO
GEAUGA CO
CREEK
CHAGRIN
RIVER
Hunting Valley
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Hunting Valley
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GENERAL MAP
JULY 1978

PLATE 1

PREFACE

The portions of the village of Waite Hill, the city of Kirtland, the village of Kirtland Hills, and the Chardon Township covered by this report are subject to flooding from the East Branch of the Chagrin River and its tributaries. The properties along these streams are primarily residential and agricultural and have been moderately damaged by the floods of 1913 and 1959. The open spaces in the flood plains which may come under pressure for future development are extensive. Although large floods have occurred in the past, studies indicate that even larger floods are possible.

This report has been prepared because a knowledge of flood potential and flood hazards is important in land use planning of flood plains. It includes a history of flooding along the East Branch of the Chagrin River and identifies those areas that are subject to possible future floods. Special emphasis is given to these floods through maps, photographs, profiles, and cross sections. The report does not provide solutions to flood problems; however, it does furnish a suitable basis for the adoption of land use controls to guide flood plain development and thereby prevent intensification of the loss problems. It will also aid in the development of other flood damage reduction techniques such as works to modify flooding and other adjustments, including flood proofing, which might be embodied in an overall Flood Plain Management (FPM) program. Other FPM program studies, those of environmental attributes and the current and future land use role of the flood plain as part of its surroundings, would also profit from this information.

The report was prepared at the request of Councils of the village of Waite Hill, the city of Kirtland, the village of Kirtland Hills, and the Trustees of Chardon Township with the endorsement of Ohio Department of Natural Resources, under continuing authority provided in Section 206 of the 1960 Flood Control Act (Public Law 86-645), as amended.

This assistance and cooperation of the Planning and Zoning Commission of the city of Kirtland, the Kirtland Library, the Mentor Public Library, the Lake County Historical Society, the News Herald of Willoughby, Ohio, the Division of Planning of the Ohio Department of Natural Resources, and private citizens in supplying useful data and photographs for the preparation of this report are appreciated.

Additional copies of this report can be obtained from the Ohio Department of Natural Resources. The Buffalo District of the Corps of Engineers, upon request, will provide technical assistance to planning agencies in the interpretation and use of the data presented as well as planning guidance and further assistance, including the development of additional information.

BACKGROUND INFORMATION

The portion of the East Branch of the Chagrin River included in this study is shown in blue on the General Map, Plate 1.

The area studied includes those sections of the flood plains along the East Branch of the Chagrin River in Lake and Geauga Counties. The portion of the East Branch of the Chagrin River within the study area extends from its mouth at the confluence with the Chagrin River (stream mile 0.00) to the Heath Road Bridge (mile 15.0). The study also includes the lower 0.5 miles of Penitentiary Glen Creek and the lower 0.8 miles of Pierson Creek.

SETTLEMENT.

The East Branch of the Chagrin River basin was part of the lands of the Connecticut Land Company. The lands were first developed by New Englanders. As the area became more populated the two counties of Geauga and Lake were established on 1 March 1806 and 6 March 1840, respectively. The area has been slowly developing since then and remains basically a rural area. Table 1 shows the population trends for political subdivisions in the watershed since 1930.

Table 1 - Population Trends

Political Subdivision	Population				
	1930	1940	1950	1960	1970
Geauga County					
Chardon Township	2,456	2,682	3,374	5,210	7,171
Lake County					
Kirtland, township	1,602	1,859	2,663	4,876	5,729
Kirtland, city	-	-	-	-	5,530
Kirtland Hills village	206	237	235	292	452
Waite Hill, village	237	289	305	360	514
TOTALS	4,501	5,067	6,577	10,738	19,396

THE STREAM AND ITS VALLEY

The East Branch of the Chagrin River drains an area of about 51.1 square miles in Northeastern Ohio. It rises two miles west of Chardon near elevation 1,280 feet, and flows southwesterly about five miles, then north-northeasterly about five miles, and then westerly about nine miles to its junction with the Chagrin River about five miles upstream from Lake Erie. The East Branch has a generally moderate slope near the mouth and becomes progressively steeper upstream.

The flood plain which contains the East Branch is relatively narrow throughout its length. Only for a short length of the stream in Kirtland Hills does the flood plain exceed 1,500 feet in width. For most of the length of the stream, the flood plain width doesn't exceed 1,000 feet.

Drainage areas contributing to runoff at locations in the study are shown in Table 2.

Table 2 - Drainage Areas

East Branch of the Chagrin River	mileage	Drainage Area Sq. Mi.
At the confluence with the Chagrin River	0.00	51.1
Upstream of the tributary at Waite Hill	2.03	45.2
Upstream of Penitentiary Glen Creek	3.77	40.9
Upstream of Pierson Creek	6.97	34.1
0.20 miles below Mitchell's Mill Road	10.61	26.5
At the Heath Road Bridge	15.00	18.8
Penitentiary Glen Creek	mouth	3.4
Pierson Creek	mouth	2.2

SOURCES OF DATA

DATA SOURCES AND RECORDS

Newspaper files, historical documents, and records were searched for information concerning past floods. Very few records of past flooding

exist. When floods did occur in the East Branch of the Chagrin River, they apparently were not as newsworthy as the corresponding floods on the adjoining Chagrin River which typically received broad coverage in the media.

The United States Geological Survey has operated a stream flow gage on the Chagrin River. The gage location is shown on Plate 1.

Field surveys were performed to obtain the necessary hydraulic information and field investigations were conducted to obtain essential flood plain information such as high water marks, flow obstructions, and existing and planned development.

The field surveys include 31 stream cross sections and cross sections of each bridge which crosses the stream and its two main tributaries. The field surveys are available from the Buffalo District of the U. S. Army Corps of Engineers. Table 4 is a list of elevation reference marks which were used in the study.

FLOOD SITUATION

FLOOD SEASON AND FLOOD CHARACTERISTICS

Major floods can occur on East Branch of the Chagrin River during any season of the year. Floods within the basin result when excessive overland runoff concentrates.

Excessive runoff in the watershed results from one of the following conditions: (1) a collision over the watershed of a large mass of warm moisture-laden air from the South Atlantic or Gulf Regions with a mass of air of low temperature from the north; these are also known as "fronts;" (2) spring floods which are normally the result of sharp rises in temperature which melt the snow cover of the basin, being frequently accompanied by rains, and (3) localized thunderstorms.

FACTORS AFFECTING FLOODING AND ITS IMPACT

Morphologic-Hydraulic Conditions - It is impossible to separate flood plains from the streams themselves in order to consider their hydrologic and hydraulic aspects. All streams have flood plains along their entire length, although their width may vary from zero, in reaches where the stream banks have perpendicular side slopes, to thousands of feet in nearly flat plains. The behavior of East Branch of the Chagrin River during flood situation is determined by both the physical properties of the normal flow channels and the physical properties of the flood plains.

Under natural conditions flood waters in excess of channel capacity spread out over valley land. All encroachments onto the flood plain should be carefully studied to assess their impact upon existing flood plain conditions and future flood stages.

Obstructions to Flood Flow - Natural obstructions to flood flows include trees, brush and other vegetation growing along the stream banks in floodway areas. Man-made encroachments on or over the streams such as dams, bridges and culverts can also create more extensive flooding than would otherwise occur. A complete listing of all the bridges over the stream up to mile 15.00 including their streambed elevation, low chord elevation, and the water surface elevation for various frequency floods is shown on Table 5.

During floods, ice, trees, brush, and other vegetation growing in floodways impede flood flows, thus creating backwater and increased flood heights. Trees and other debris may be washed away and carried downstream to collect on bridges and other obstructions to flow. The debris plugs the bridge or culvert entrances and retards flood flows. These retarded flood flows produce additional upstream flooding, erosion around the culvert entrances and bridge approach embankments, and possible damage to the overlying road bed. When masses of debris break loose, the debris and impounded water surge downstream until another obstruction is encountered. Debris may collect against a bridge until the load exceeds its structural capacity and the bridge is destroyed.

In general, obstructions restrict flood flows and result in overbank flows and unpredictable areas of flooding, destruction and damage to bridges and culverts. It is impossible to predict the degree or location of the accumulation of debris; therefore, for the purposes of this report, it was assumed that there would be no accumulation of debris at any of the bridges or culverts. Examples of obstructions to flow are shown in Figures 1 and 2. Photographs of typical bridges crossing are shown in Figures 3 through 13.

UNIFIED FLOOD PLAIN MANAGEMENT PROGRAMS

Historically, the alleviation of flood damage has been accomplished almost exclusively by the construction of protective works such as reservoirs, channel improvements, and flood walls and levees. However, in spite of the billions of dollars that have already been spent for construction of well designed and efficient flood control works, annual flood damages continue to accelerate because the number of persons and structures occupying flood prone lands is increasing faster than protective works can be provided.

Recognition of this trend in recent years has forced a reassessment of the flood control concept and resulted in the broadened concept of unified flood plain management programs. A unified flood plain management program is composed of five overlapping components. The first is conventional structural measures including various combinations of reservoir storage, levees, and channel improvement. The second is land use management which indicates the type of development which should be located within a specific flood prone area. The third is flood proofing which sets forth the design, use and maintenance of those developments located on the flood plain to minimize losses when floods occur. The fourth is the development of adequate emergency preparations including flood forecasting and temporary evacuation procedures. The fifth is the establishment of adequate flood insurance and catastrophy-aftermath relief measures to insure against total collapse of an area's economy and to provide the individuals and businesses affected a means with which to rebuild and re-establish. Floods have first priority on the flood plains and man should recognize this "fact of life" before encroaching. The concept of unified flood plain management can be expressed as the realization that in many instances it is far better for man to adjust to nature rather than to have nature adjust to man.

Flood Plain Regulations - Flood plain regulation applies to the full range of ordinances and other means designed to control land use and construction within flood prone areas. The term encompasses zoning ordinances, subdivision regulations, building and housing codes, encroachment line statutes, open area regulations, and other similar methods of management affecting the use and development of flood prone areas.

Flood plain land use management does not prohibit use of flood prone areas; to the contrary, flood plain land use management seeks the best use of flood plain lands. The flood plain maps, the water surface profiles, and the cross-sections contained in this report can be used to guide development in the flood plain. The elevations shown on the profiles should be used to determine flood heights because they are more accurate than the flooded outlines. Development in areas susceptible to frequent flooding should consist of construction which has a low damage potential such as parking areas. If high value construction such as buildings are considered for areas subject to frequent flooding, the land should be elevated to minimize damages. If it is uneconomical to elevate the land in these areas, means of flood proofing the structures should be given careful consideration.

Development Zones - A flood plain can be conceptualized as consisting of two useful zones. The first being the designated "floodway" or

that cross-sectional area required for carrying or discharging the anticipated flood waters. Velocities are greatest and most damaging in the floodway. Regulations essentially maintain the flow conveying capability of the floodway to minimize inundation of additional adjacent areas. Uses which are acceptable for floodways include parks, parking areas, open spaces, etc. The vegetation cover of the floodways could be used as overland "Living Filters" for surface runoff during normal flow periods to reduce the pollutional impact of surface runoff prior to interception by the water course.

The second zone of the flood plain is termed the "floodway fringe" or restrictive zone, in which inundation might occur but where depths and velocities are generally low. Such areas can be developed provided structures are placed high enough or flood proofed to be reasonably free from flood damage during the Intermediate Regional (100-year) Flood.

Formulation of Flood Plain Regulations - Formulation of flood plain regulations in a simplified sense involves selecting the type and degree of control to be exercised for each specific flood plain. In principal, the form of the regulations is not as important as a maintained adequacy of control. The degree of control normally varies with the flood hazard as measured by depth of inundation, velocity of flow, frequency of flooding, and the need for available land. Considerable planning and research is required for the proper formulation of flood plain regulations. Where formulation of flood plain regulation is envisioned to require a lengthy period of time during which development is likely to occur, temporary regulations should be adopted to be amended as necessary.

National Flood Insurance Program - The National Flood Insurance Act of 1968 provides previously unavailable flood insurance protection to property owners in flood-prone areas. The program is administered by the Federal Insurance Administration (FIA) of the U. S. Department of Housing and Urban Development (HUD) and is subsidized by Federal funds. It operates through an insurance industry pool under the auspices of the National Flood Insurers Association.

To qualify for the sale of Federally subsidized flood insurance, a community must agree to adopt and enforce adequate land use and control measures consistent with Federal criteria. These criteria usually require a floodprone community to control development within the area anticipated to be inundated by the 100-year flood.

OTHER FACTORS AND THEIR IMPACTS

Flood Warning and Forecasting - At present there is no flood warning or forecasting network within the basin. However, the Surveillance Radar operated continuously by the National Weather Service at the Cleveland Airport can provide for early detection of a storm and information concerning the predicted path and amount of rainfall can be broadcasted by radio and television to affected areas. Appropriate action can then be taken to minimize flood losses.

Flood fighting and emergency evacuation plans - Although there are no formal flood fighting or emergency evacuation plans for the study area, provisions for alerting area residents and coordinating operations of city and county public service agencies in time of emergency are accomplished through the local governing agencies.

Material storage on the flood plain - Because the flood plain of the East Branch of the Chagrin River is largely undeveloped, there is very little danger of manmade floating materials being carried away by floodflows. However, a serious danger does exist because substantial quantities of dead timber from forested areas may be carried downstream by the floodflows.

Figure 1 - An example of a natural obstruction to flow on the East Branch of the Chagrin River.

Figure 2 - Natural channel and overbank conditions for the East Branch of the Chagrin River.

Photos taken April 1976

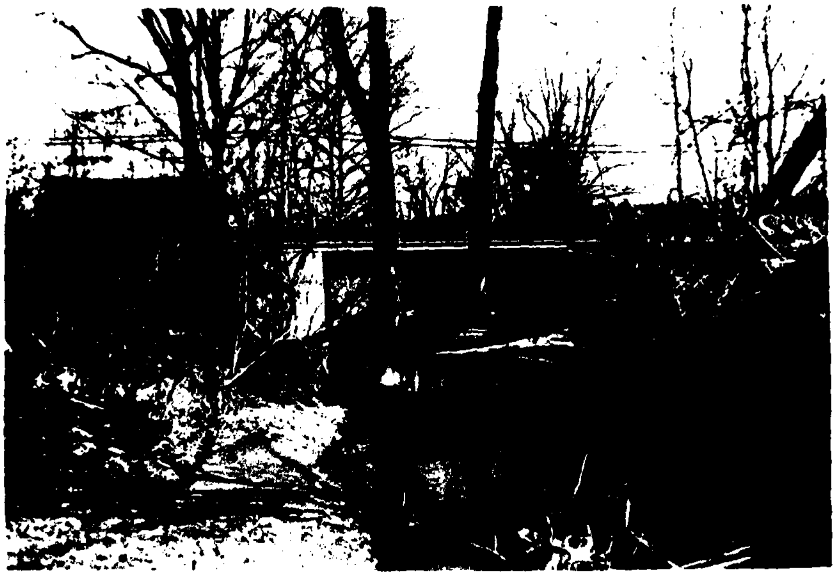


Figure 3 - Upstream view of the Kirtland-Chardon Road Bridge at stream mile 0.06 over Penitentiary Glen Creek. Note the natural obstructions in the channel.

Figure 4 - Upstream view of the Markell Road Bridge at stream mile 2.52.

Photos taken April 1976

Figure 5 - Upstream view of the Route 306 Bridge at stream mile 2.97.

Figure 6 - Upstream view of the Chillicothe Road Bridge at stream mile 3.72.

Photos taken April 1976

Figure 7 - Upstream view of Booth Road Bridge at stream mile 6.93.

Figure 8 - Upstream view of Mitchells Mill Road Bridge at stream mile 10.81.

Photos taken April 1976

Figure 9 - Upstream view of Wisner Road Bridge at stream mile 12.[illegible]1.

Figure 1[illegible] - Upstream view of the Kirtland-Chardon Road Bridge at stream mile 1[illegible].[illegible].

Photos taken April 19[illegible]6

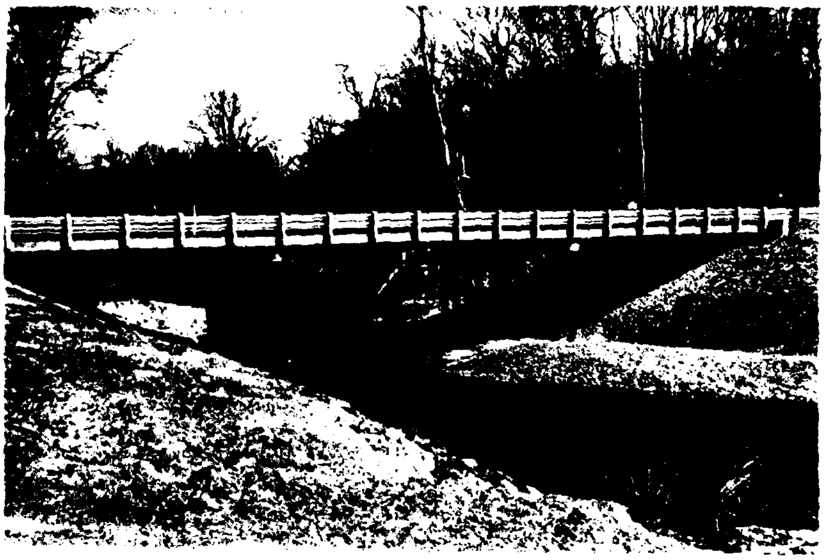


Figure 11 - Upstream view of the Route 6 Bridge at stream mile 14.38.

Figure 12 - Upstream view of the Heath Road Bridge at stream mile 15.00.

Photos taken April 1976

Figure 13 - Upstream view of the Sperry Road Bridge over Pierson Creek at stream mile 0.03.

Figure 14 - Downstream view of the dam at the Kirtland Country Club at stream mile 2.09.

Photos taken April 1976

PAST FLOODS

FLOOD DESCRIPTION

There is very little historical information on flooding in the basin. Local libraries, newspapers, and historians were contacted in an attempt to find records of past flooding. Previous floods on the East Branch of the Chagrin River were seldom recorded because of the rural nature of the basin. The extensive records of flooding on the Chagrin River were used to determine other important flood dates.

a. March 1913 Flood. Heavy rains during the periods 13-15 and 20-21 March were preliminary to the severe storm experienced from 23-27 March. Two low-pressure centers combined to form a long, low pressure trough which produced excessive rainfall in Ohio and neighboring states for about 60 hours. Belefontaine, located about 140 miles southwest of the Chagrin River basin, along the northeast edge of the storm, received an average of 7.56 inches of rainfall during the period.

b. January 1959 Flood. This flood event was the result of heavy rains on the 20th which fell on frozen ground previously blanketed by a six-inch snow cover. The storm developed from a large mass of cold air over northwestern Canada, a flow of warmer air from the southwest and the associated frontal system. Although total storm rainfall was not excessive, intensities were high which, when combined with the significant snow pack, produced high runoff rates during the period.

FUTURE FLOODS

Floods of the same or larger magnitude as those that have occurred in the past are likely to occur sometime in the future. Larger floods have been experienced in the past on streams with similar geographical and physiographical characteristics as those found in the study area. Similar combinations of rainfall and runoff which caused these floods could occur within the study area. Therefore, to assess the flooding potential of the study area, it was necessary to consider storms and floods that have occurred in regions of like topography, watershed cover and physical characteristics.

FLOOD MAGNITUDES AND THEIR FREQUENCIES.

There are no active gaging stations on East Branch of the Chagrin River, consequently a statistical approach to determining flood discharges

would not be possible. Nearby streams having the same basic characteristics were used in a regional frequency analysis. This analysis resulted in a mean annual flow versus drainage area relationship, which was developed into discharge-frequency curves.

The discharge-frequency curves mentioned above relate different discharge values to the frequency of their occurrence. It is used to describe the size of floods which will be equaled to or exceeded on the average of once every 500, 100, 50 or 10 years. Such a curve can define floods for any given number of years. It is important to note that, while on a long-term basis the occurrence (e.g. 100 years) averages out to be once per time interval (e.g. 100 years), floods of any given magnitude can occur in any year or even in consecutive years and within any time interval. For example, it is possible to have several 100-year floods in a given 100-year period, although it is unlikely. A useful example to help understand the 100-year flood is that a house which is built at the 100-year flood level has a one in four chance of being flooded in a 30-year mortgage life. Also, there is a 50% chance that a 100-year flood event will occur during a 70-year lifetime.

Table 3 is a summary of peak discharge values for different intervals (in years) at various points along the East Branch of the Chagrin River.

Floods larger then the 500-year flood are possible, however, the probability of the necessary coincident climatic conditions arising is sufficiently remote to preclude their consideration. Although it would be catastrophic if such floods occurred in a developed stream valley, their size and rarity are such that protection against them by protective works can seldom be economically provided.

HAZARDS AND DAMAGES OF LARGE FLOODS

The extent of damage caused by any flood depends on the topography of the area flooded, depth and duration of flooding, velocity of flow, rate of rise in water surface elevation and developments in the flood plain. Deep flood water flowing at high velocity and carrying floating debris would create conditions hazardous to persons and vehicles attempting to cross flooded areas. In general, flood water three or more feet deep and flowing at a velocity of three or more feet per second, could easily sweep an adult person off his feet, thus creating definite danger of injury or drowning. Rapidly rising and swiftly flowing flood water may trap persons in homes that are ultimately destroyed, or in vehicles that are ultimately submerged or floated.

Water lines can be ruptured by deposits of debris and the force of flood waters, thus creating the possibility of contaminated domestic water supplies. Damaged sanitary sewer lines and sewage treatment plants could result in the pollution of flood waters creating health hazards. Isolation of areas by flood water could create hazards in terms of medical, fire or law enforcement emergencies.

Flooded Areas - The Index Map, Plate 2, locates the flooded area maps, Plates 3 through 5. The areas that would be flooded by the 100-year and 500-year Floods are shown in detail on Plates 3 through 5. The actual limits of these overflow areas may vary somewhat from those shown on the maps because the 10-foot contour interval and scale of the maps do not permit precise plotting of the flooded area boundaries. Plates 6 through 11 show water surface profiles for the 500, 100, 50 and 10 year Floods. Depth of flow in the channel can be estimated from these illustrations. Typical cross sections of the flood plain at selected locations, together with the water surface elevation and lateral extent of the 500- and 100-year Floods are shown on Plates 12 through 14.

Table 4 is a list of elevation reference marks. The list is furnished as an aid to local interests in setting minimum elevations for future development or establishing other elevations necessary to flood plain planning.

Obstructions - During floods, debris collecting on bridges could decrease their flow carrying capacity and cause greater water depths (backwater effect) upstream of these structures. Since the occurence and amount of debris are indeterminate factors, only the physical characteristics of the structures were considered in preparing the profiles. No reduction in carrying capacity from clogging or jamming were considered. Similarly, the maps of flooded areas show the backwater effect of obstructive bridges, but do not reflect increased water surface elevations that could be caused by debris collecting against the structures. Of the 17 bridges listed in Table 5 crossing the East Branch of the Chagrin River, most of them are obstructive to the 100-year flood and even more are obstructive to the 500-year flood. In some cases bridges may be high enough so as not to be inundated by flood flows; however, the approaches to these bridges may be at lower elevations and subject to flooding and rendered impassible.

Table 5 summarizes pertinent bridge data and lists water surface elevations for the 500- and 100- year floods at bridges that cross the East Branch of the Chagrin River, Penitentiary Glen Creek and Pierson Creek.

Velocities of Flow - Water velocities during floods depend largely on the size and shape of the cross sections, the conditions of the stream, and the bed slope, all of which vary on different streams and at different locations on the same stream. Table 6 shows average channel and overbank velocities for the 100-year and the 500-year flood. During an 100-year flood, velocities of the main channel flow in the East Branch of the Chagrin River in the study area would range up to about 13 feet per second. Water flowing at this rate is capable of causing severe erosion to stream banks and embankments at bridge abutments and transporting large objects. Overbank flow in the study area would average 1 to 6 feet per second. Water flowing at 2 feet per second or less would deposit debris and silt.

Rates of Rise and Duration of Flooding - Rates of rise are dependent upon the shape of the basin antecedent conditions, intensity of the storm, development within the basin, and debris in the channel at the time of the storm.

The duration of a flood is dependent upon the duration of the storm, the storage capacity of the overbank, prolonged runoff from snowmelt, and high stages caused by ice jams, etc.

It is impossible to predict accurate rates of rise and duration because many variations in rainfall distribution could produce the 100-year flood peak discharge with a variety of rise rates.

A study of the nature of flooding within the study area indicates that the East Branch of the Chagrin River through the study area is prone to rapid and dangerous rates of rise.

Photographs, Future Flood Heights - The expected levels of the 100-year and 500-year floods for various locations in the study area are indicated on Figures 15 and 16.

Table 3 - Peak Flows for the East Branch of the Chagrin River

Location	Stream Mile	Drainage Area (Sq. Mi.)	10-Year Flood Discharge (cfs)	50-Year Flood Discharge (cfs)	100-Year (IRF) Flood Discharge (cfs)	500-Year Flood Discharge (cfs)
Mouth of the East Branch of the Chagrin River	0.00	51.1	5,500	7,690	8,600	11,000
Upstream of Penitentiary Glen Creek	3.77	40.9	4,700	6,770	7,600	9,600
Near St. Huberts Church on Baldwin Road	6.34	36.4	4,450	6,300	7,100	9,100
Upstream of Pierson Creek	6.97	34.1	4,300	6,030	6,850	8,800
0.20 miles below Mitchells Mill Road Bridge	10.61	26.5	3,750	5,300	6,000	7,700
0.80 miles below Kirtland Road Bridge	12.56	22.4	3,350	4,400	5,450	7,000
Heath Road Bridge	15.00	18.8	2,900	4,300	4,950	6,350
Mouth of Penitentiary Glen Creek	0.00	3.4	1,000	1,480	1,700	2,200
Mouth of Pierson Creek	0.00	2.2	800	1,170	1,340	1,770

Table 4 - Elevation Reference Marks for the East Branch of the Chagrin River

Bench Mark Designation and approximate River Mile	Elevation in Feet on U.S.C.&G.S. Datum	Description
Chagrin River Dam (0.10 miles below the mouth of the East Branch of the Chagrin River on the Chagrin River)	607.50	U.S.G.S. Disk on the left abutment of the dam which is just below the Ridge Road Bridge (Rt. 84).
Interstate Route 90 (0.42)	656.46	Chiseled square on the S.E. corner of the Upstream Bridge abutment on Rt. 90 eastbound.
Kirtland Country Club Bridge No. 2 (2.14)	634.32	Chiseled square on the concrete abutment of the downstream left bank of the bridge.
Markell Road Bridge (2.52)	639.03	Chiseled square on the top of the upstream right bank abutment of the Markell Road Bridge
Rt. 306 and Markell Rd. (2.97)	643.09	Disk set in the top of a concrete post at the S.W. corner of Rt. 306 and Markell Road
Chillicothe Road (3.72)	661.22	Top of a horizontal R.R. spike in a Power Pole (#899346) on the north side of Chillicothe Road.
Baldwin Road (5.89)	684.60	U.S.C.&G.S. Disk set in the top of a concrete post on the north side of Baldwin Road.
Booth Road Bridge (6.93)	723.35	Chiseled square on the top of the S.E. abutment of the Booth Road Bridge.
Mitchell's Mill Road (10.81)	832.01	Chiseled square on the top of the concrete curb at the S.E. corner of the Mitchell's Road Bridge.

Table 4 - Elevation Reference Marks for the East Branch of the Chagrin River

Bench Mark Designation and approximate River Mile	Elevation in Feet on U.S.C.&G.S. Datum	Description
Wisner Road (12.01)	852.95	Chiseled square on the top of the S.E. abutment of Wisner Road.
Kirtland Road Bridge (12.80)	874.81	Chiseled square on the top of the N.E. abutment of the Kirtland Road Bridge.
Route 6 Bridge (14.38)	911.37	Yellow mark painted on an iron on the S.W. corner of the Rt. 6 Bridge.
Heath Road Bridge (15.00)	917.81	Chiseled square on the top of the N.W. abutment of the Heath Road Bridge.
Sperry Road Bridge over Pierson Creek (0.03)	719.99	Chiseled square on the top of the S.W. abutment of the Sperry Road Bridge.

Table 5 - Bridges Across the East Branch of the Chagrin River and Principal Tributaries

Bridge	Mileage above Mouth	Approximate Stream Bed Elevation	Approximate Low Chord Elevation	Approximate Bridge Floor Elevation	Water Surface Elevation(a) 100-Year	Water Surface Elevation(a) 500-Year
Interstate Route 90 (Eastbound bridge)	0.42	601.4	646.5	653.0	617.2	619.8
Kirtland Country Club Bridge No. 1	1.86	614.0	630.8	632.7	627.9	629.4
Kirtland Country Club Bridge No. 2	2.14	619.3	637.2	637.4	630.6	631.3
Kirtland Country Club Bridge No. 3	2.38	622.0	637.5	639.3	633.4	634.3
Markell Road Bridge	2.52	623.0	636.0	639.3	634.5	635.4
Route 306	2.97	628.1	641.4	644.4	639.7	641.1
Chillicothe Road Bridge	3.72	638.1	655.5	659.4	649.8	651.2
Booth Road Bridge	6.93	702.4	718.1	722.2	713.5	715.0
Mitchells Mill Road Bridge	10.81	819.9	829.5	832.1	830.5	831.7

Table 5 - Bridges Across the East Branch of the Chagrin River (Cont'd)

Bridge	Mileage above Mouth	Approximate Stream Bed Elevation	Approximate Low Chord Elevation	Approximate Bridge Floor Elevation	Water Surface Elevation 100-Year	Water Surface Elevation 500-Year
Wisner Road Bridge	12.01	840.8	851.7	855.5	851.9	853.5
Kirtland Road Bridge	12.80	852.4	871.1	874.5	867.6	869.0
Route 6 Bridge	14.38	890.0	908.5	911.0	899.6	900.9
Heath Road Bridge	15.00	(d)	(d)	902.2	913.6(e)	914.5(e)
Penitentiary Glen Creek						
Kirtland-Chardon Road Bridge	0.06	642.1	653.8	660.5	652.0	654.0
Pierson Creek						
Sperry Road Bridge	0.03	706.7	718.0	720.5	715.2	717.2
Private Driveway	0.25	723.4	734.4	736.7	732.8	734.6
Private Driveway	0.42	738.5	744.4	746.1	746.0	747.0

Note: All elevations are on the U.S.C.&G.S. Datum.

(a) All elevations are on the upstream side of the bridge unless otherwise noted.
(b) The elevation at the downstream base of the dam.
(c) The elevation of the crest of the dam.
(d) Not available.
(e) This elevation is at the downstream face of the bridge.

Table 6 - 100- and 500-Year Flood Discharges and Average Velocities

Stream Mile	Discharge in cfs 100-Year	Discharge in cfs 500-Year	Average Velocity (feet per Second) Channel 100-Year	Channel 500-Year	Overbank 100-Year	Overbank 500-Year
1.42	8,600	11,000	7.9	8.5	1.1	1.1
2.05	8,000	10,100	4.2	4.2	2.2	2.3
3.60	8,000	10,100	11.4	12.7	2.6	2.6
4.17	7,600	9,600	6.9	6.9	1.9	2.1
6.29	7,350	9,400	9.2	9.8	3.4	3.8
7.29	6,650	8,500	8.5	9.6	3.8	5.5
10.15	6,650	8,500	12.7	13.3	4.4	3.9
11.21	5,700	7,300	10.5	11.5	3.9	4.5
13.09	5,450	7,000	6.7	6.8	2.9	3.2
14.13	5,450	7,000	6.4	6.9	0.0	0.5
Penitentiary Glen Creek						
0.21	1,700	2,200	9.2	8.9	1.9	2.1
Pierson Creek						
0.44	1,340	1,770	3.7	4.8	1.2	1.5

Figure 15 - The 100 and 500 year flood heights on the Pumphouse at the Kirtland Country Club at stream mile 2.12.

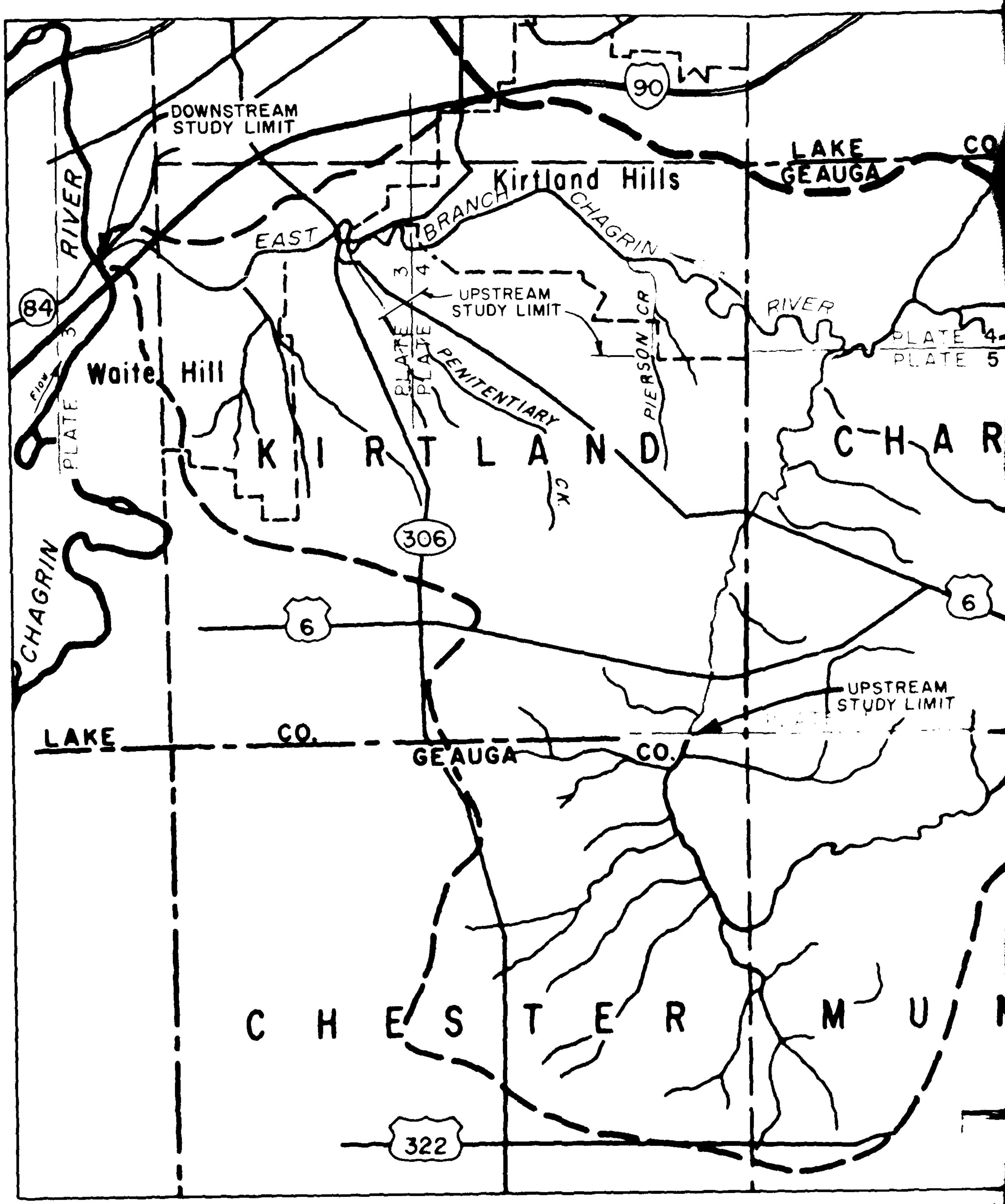
Figure 16 - The 100 and 500 year flood heights at St. Hubert's Church at stream mile 6.31.

Photos taken April 1976

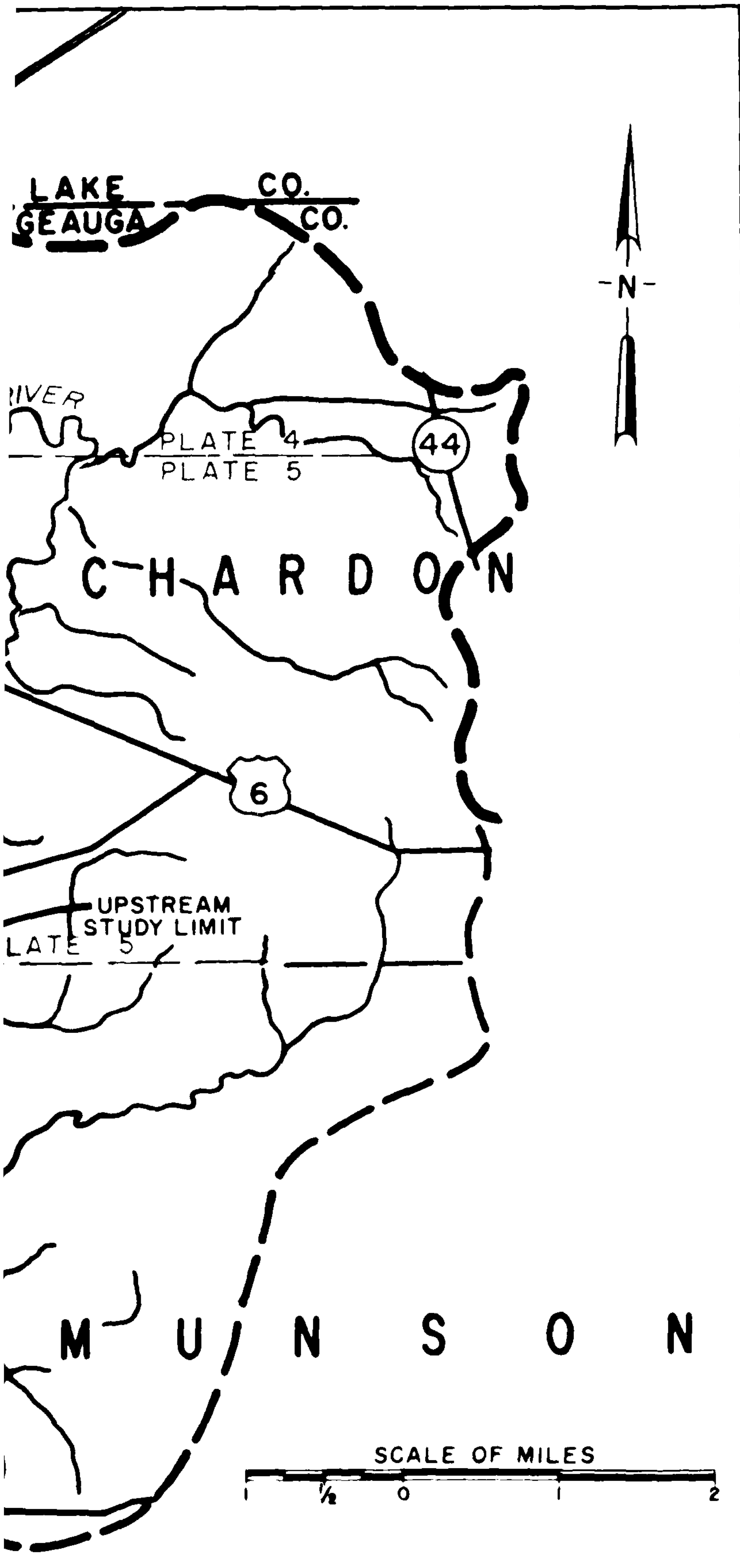
GLOSSARY

BACKWATER	The resulting high water surface in a given stream due to a downstream obstruction or high stages in an intersecting stream.
DISCHARGE	The quantity of flow in a stream at any given time, usually measured in cubic feet per second (cfs).
FLOOD	An overflow of lands not normally covered by water and that are used or usable by man. Floods have two essential characteristics: The inundation of land is temporary; and the lands are adjacent to and inundated by overflow from a river, stream, ocean, lake, or other body of standing water. Normally a "flood" is considered as any temporary rise in streamflow or stage, but not the ponding of surface water, that results in significant adverse effects in the vicinity. Adverse effects may include damages from overflow of land areas, temporary backwater effects in sewers and local drainage channels, creation of unsanitary conditions or other unfavorable situations by deposition of materials in stream channels during flood recessions, rise of ground water coincident with increased streamflow, and other problems.
FLOOD CREST	The maximum stage or elevation reached by waters of a flood at a given location.
FLOOD PLAIN	The areas adjoining a river, stream, watercourse, ocean, lake or other body of standing water that have been or may be covered by floodwater.
FLOOD PROFILE	A graph showing the relationship of water surface elevation to location, the latter generally expressed as distance above mouth for a stream of water flowing in an open channel. It is generally drawn to show surface elevation for the crest of a specific flood but may be prepared for conditions at a given time or stage.

FLOOD STAGE	The stage or elevation at which overflow of the natural banks of a stream or body of water begins in the reach or area in which the elevation is measured.
FLOODWAY	The channel of a watercourse and that portion of the adjoining flood plain required to provide for the passage of the Intermediate Regional Flood.
INTERMEDIATE REGIONAL FLOOD	A flood having an average frequency of occurrence in the order of once in 100 years although the flood may occur in any year. It is based on statistical analysis of streamflow records available for the watershed and analysis of rainfall and runoff characteristics in the general region of the watershed. It is commonly referred to as the "100 year flood."
LOW CHORD	The elevation at the top of the opening of a bridge or other structure through which water may flow along a watercourse.



DOWNSTREAM STUDY LIMIT
90
LAKE
GEAUGA
CO
Kirtland Hills
EAST
BRANCH
CHAGRIN
RIVER
UPSTREAM STUDY LIMIT
PIERSON CR
PLATE 3
PLATE 4
PLATE 4
PLATE 5
84
Flow
Waite Hill
PENITENTIARY
CK.
K I R T L A N D
C H A R
306
CHAGRIN
6
6
UPSTREAM STUDY LIMIT
LAKE CO.
GEAUGA CO.
C H E S T E R
M U
322



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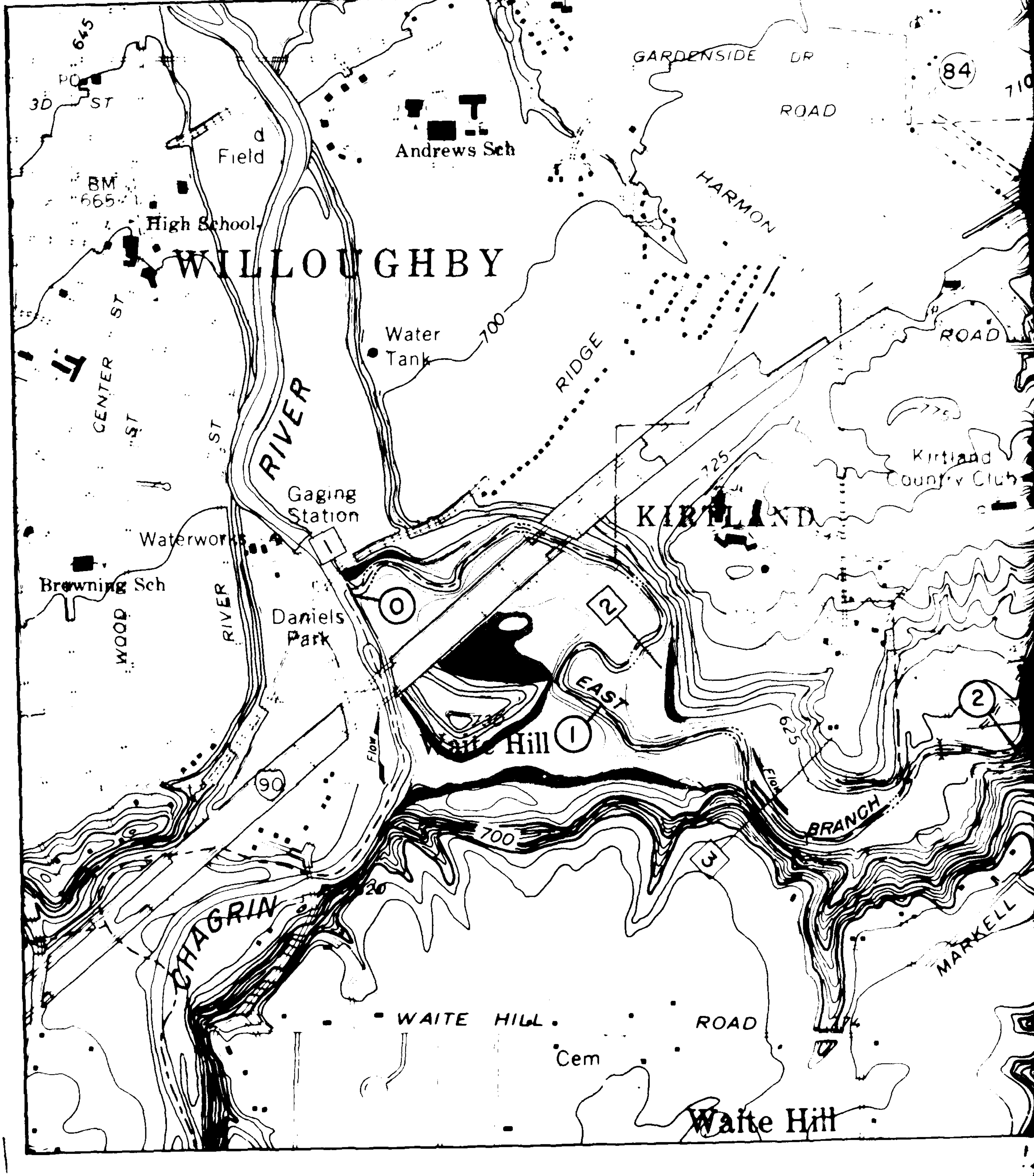
BUFFALO, NEW YORK

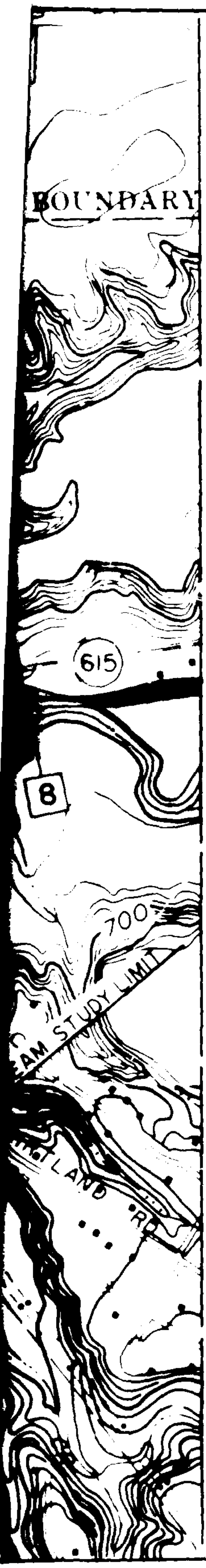
FLOOD PLAIN INFORMATION
LAKE AND GEAUGA COUNTIES, OHIO
EAST BRANCH CHAGRIN RIVER

INDEX MAP

JULY 1976


645
PO
3D ST
Field
Andrews Sch
GARDENSIDE DR
ROAD
84
710
BM
665
High School
WILLOUGHBY
HARMON
CENTER ST
ST
Water
Tank
700
RIDGE
ROAD
RIVER
775
Kirtland
Country Club
725
Gaging
Station
KIRTLAND
Waterworks
1
Browning Sch
0
2
Daniels
Park
WOOD
RIVER
EAST
1
2
Waite Hill
625
Flow
90
BRANCH
700
3
CHAGRIN
MARKELL
WAITE HILL
ROAD
Cem
Waite Hill

MATCH LINE PLATE 4



MATCH LINE PLATE 4

LEGEND

4 CROSS SECTION

CHANNEL LIMITS

3 MILES ABOVE MOUTH

800 GROUND ELEVATION IN FEET (U.S.C. & G.S. 1927 NORTH AMERICAN DATUM.)

100-YEAR FLOOD

500-YEAR FLOOD

NOTES

1. MAP BASED ON U.S.G.S. 7.5 MIN. QUADRANGLE SHEET, CHESTERLAND, MENTOR, MAYFIELD HEIGHTS & EASTLAKE 1963. MINOR ADDITIONS AND ADJUSTMENTS MADE BY CORPS OF ENGINEERS.

2. LIMITS OF OVERFLOW SHOWN MAY VARY FROM ACTUAL LOCATION ON GROUND AS EXPLAINED IN THE REPORT.

3. AREAS OUTSIDE THE FLOOD PLAIN MAY BE SUBJECT TO FLOODING FROM LOCAL RUNOFF.

4. MINIMUM CONTOUR INTERVAL IS 10 FT.

SCALE IN FEET

0 1000 2000

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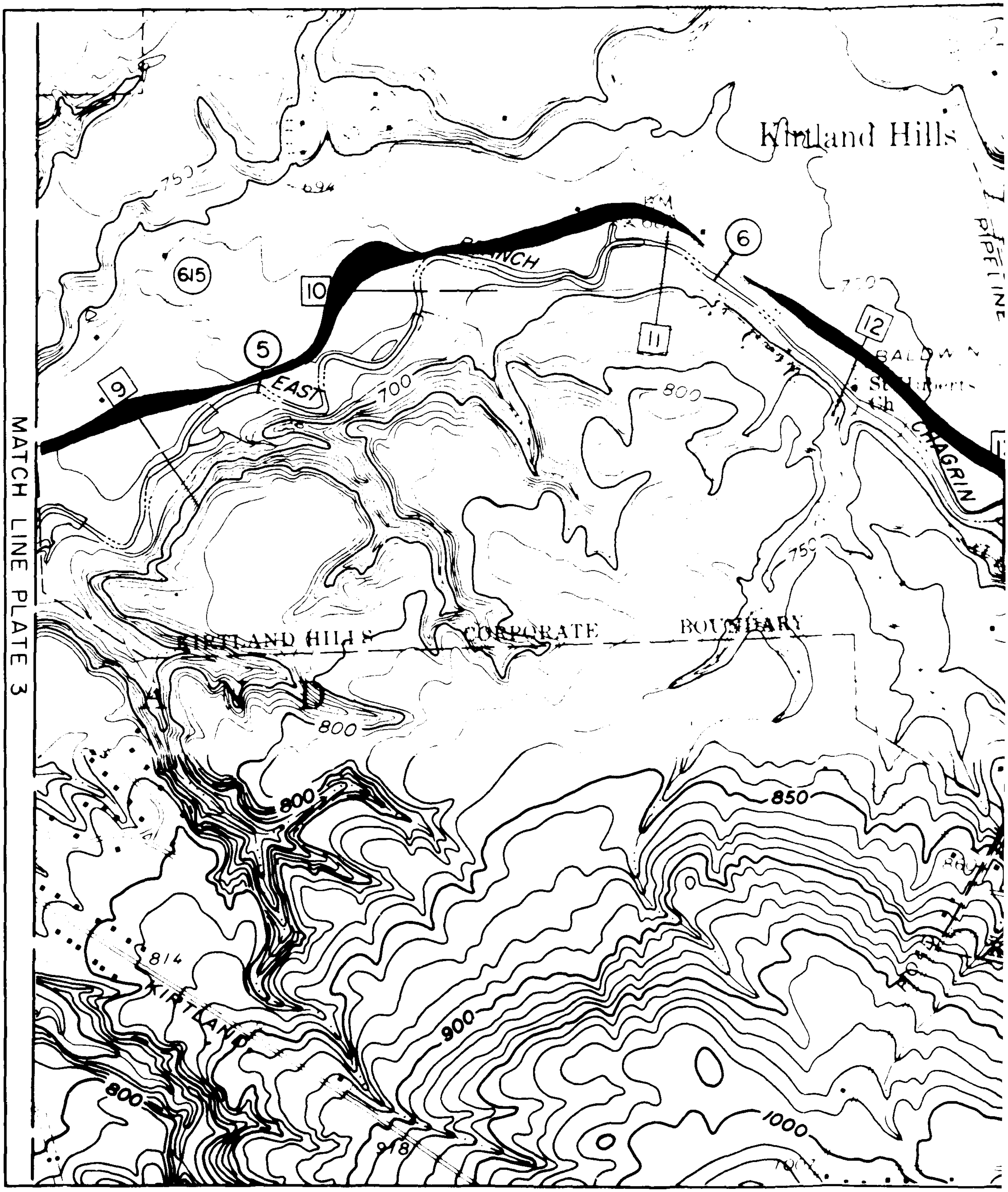
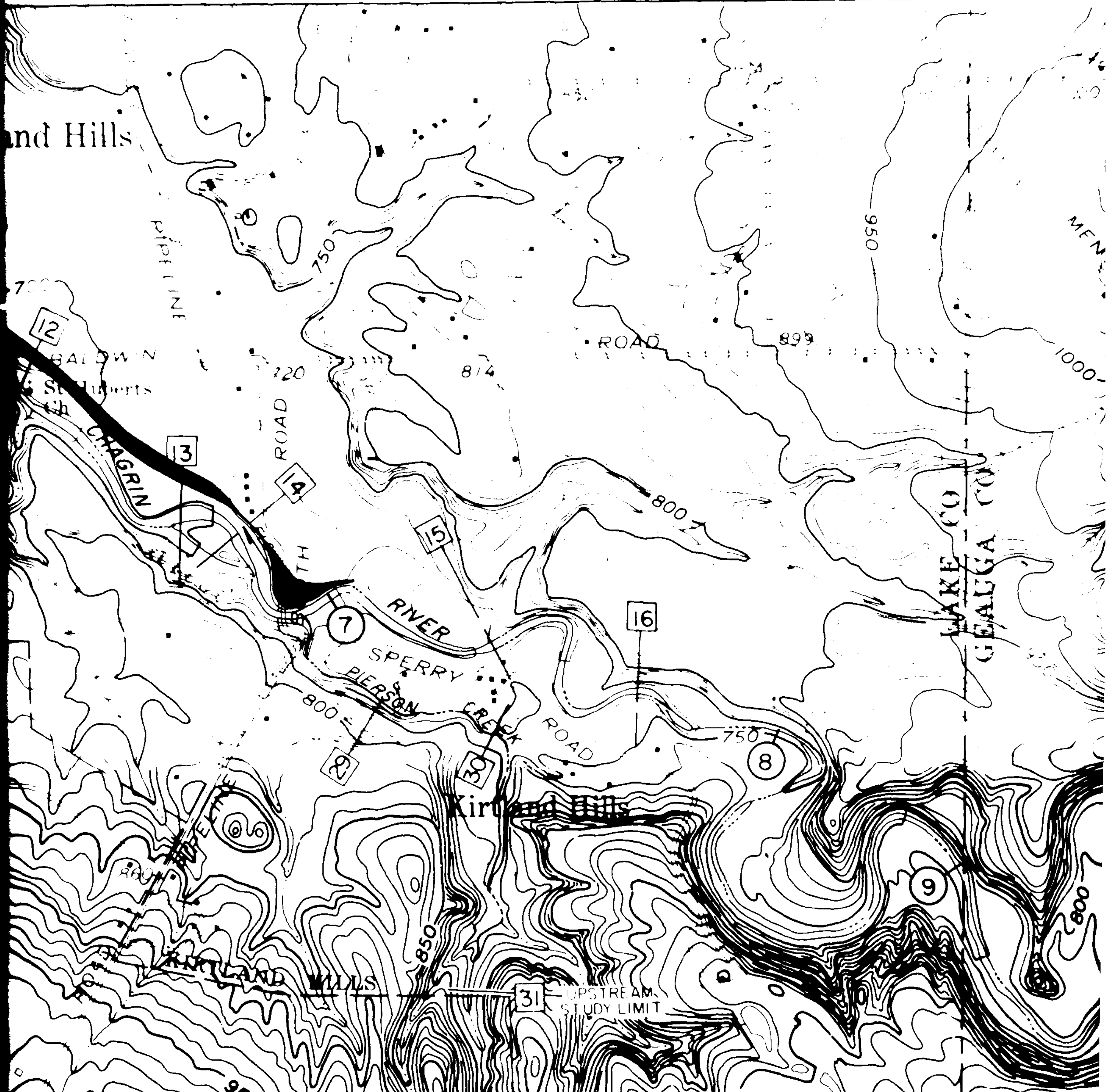
BUFFALO DISTRICT, CORPS OF ENGINEERS
BUFFALO, NEW YORK

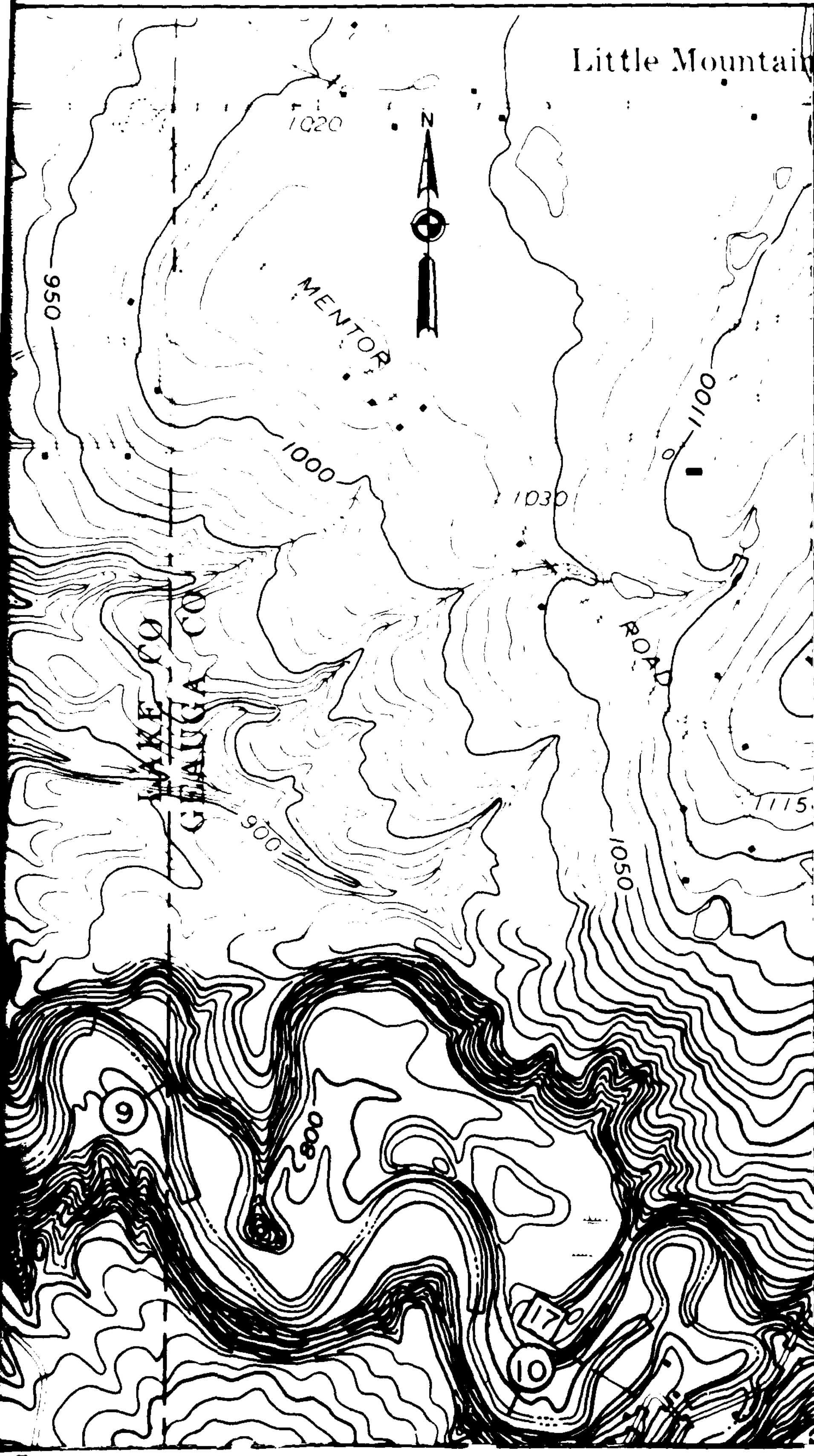
FLOOD PLAIN INFORMATION
LAKE AND GEAUGA COUNTIES, OHIO
EAST BRANCH CHAGRIN RIVER

FLOODED AREAS


MATCH LINE PLATE 3
Kirtland Hills
KIRTLAND HILLS CORPORATE BOUNDARY
EAST BRANCH
CHAGRIN
BALDWIN
KIRTLAND
PIPELINE
615
694
750
700
800
850
900
1000
814
918
5
6
9
10
11
12



Kirtland Hills
PIPELINE
BALDWIN
St Huberts Ch
CHAGRIN
RIVER
ROAD
ROAD
SPERRY
PIERSON
CREEK
ROAD
Kirtland Hills
KIRTLAND HILLS
UPSTREAM STUDY LIMIT
LAKE CO
GEAUGA CO
12
13
14
15
16
7
8
9
29
30
31
750
720
814
800
899
950
1000
750
800
850
950
950
800
MATCH LINE PLATE 5



LEGEND

4 CROSS SECTION

CHANNEL LIMITS

3 MILES ABOVE MOUTH

GROUND ELEVATION IN FEET (U.S.C & G.S 1927 NORTH AMERICAN DATUM.)

100-YEAR FLOOD

500-YEAR FLOOD

NOTES

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SCALE IN FEET

0 1000 2000

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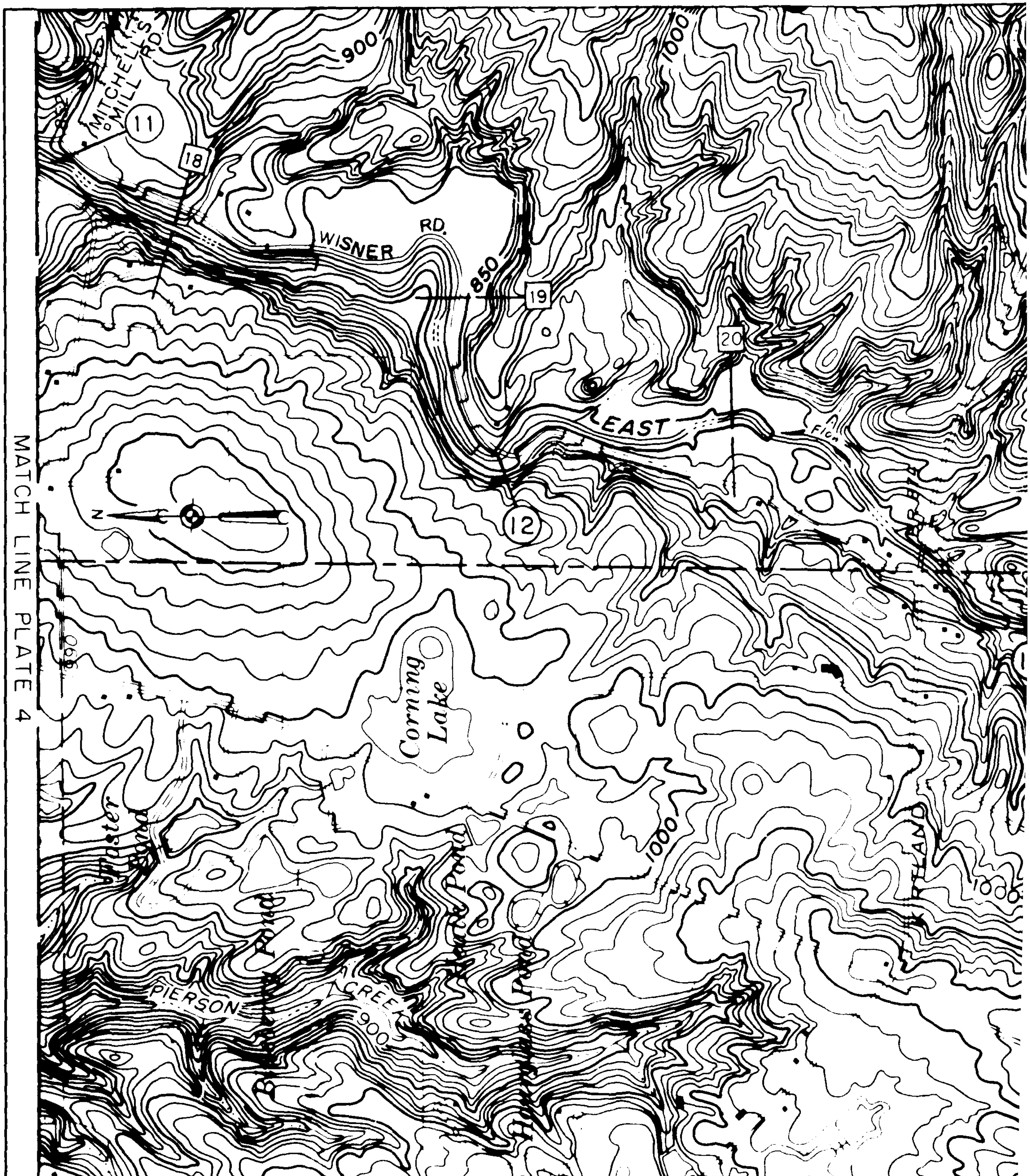
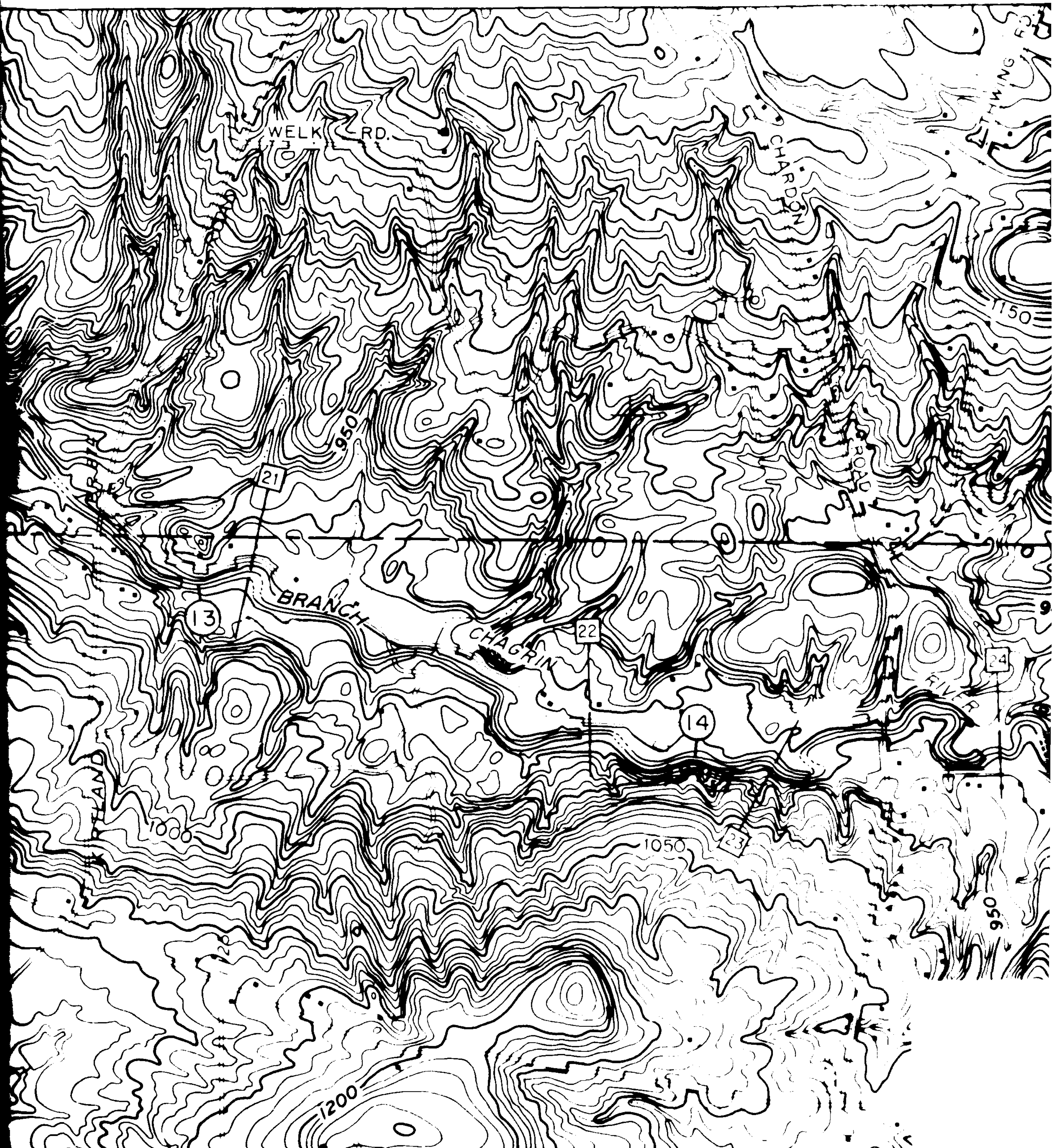
BUFFALO, NEW YORK

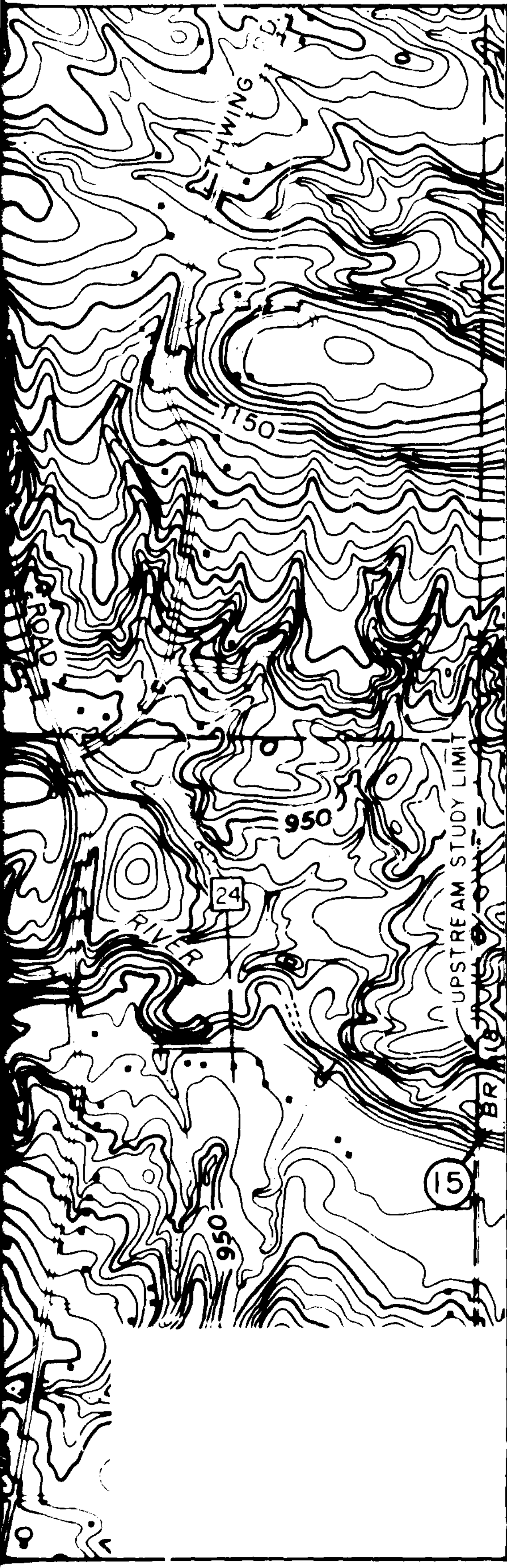
FLOOD PLAIN INFORMATION
LAKE AND GEAUGA COUNTIES, OHIO
EAST BRANCH CHAGRIN RIVER

FLOODED AREAS

JULY 1976


MATCH LINE PLATE 4
MITCHELL'S MILL RD.
11
18
900
1000
WISNER RD.
850
19
20
EAST
12
N
Corning Lake
1000
PIERSON CREEK
900


WELK RD.
CHARDON
THWING
1150
950
21
ROAD
13
BRANCH
CHAGRIN
22
14
24
RIVER
1000
1050
23
950
1200



LEGEND

4 CROSS SECTION

CHANNEL LIMITS

3 MILES ABOVE MOUTH

GROUND ELEVATION IN FEET (U.S.C. & G.S. 1927 NORTH AMERICAN DATUM)

100-YEAR FLOOD

500-YEAR FLOOD

NOTES

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SCALE IN FEET

0 1000 2000

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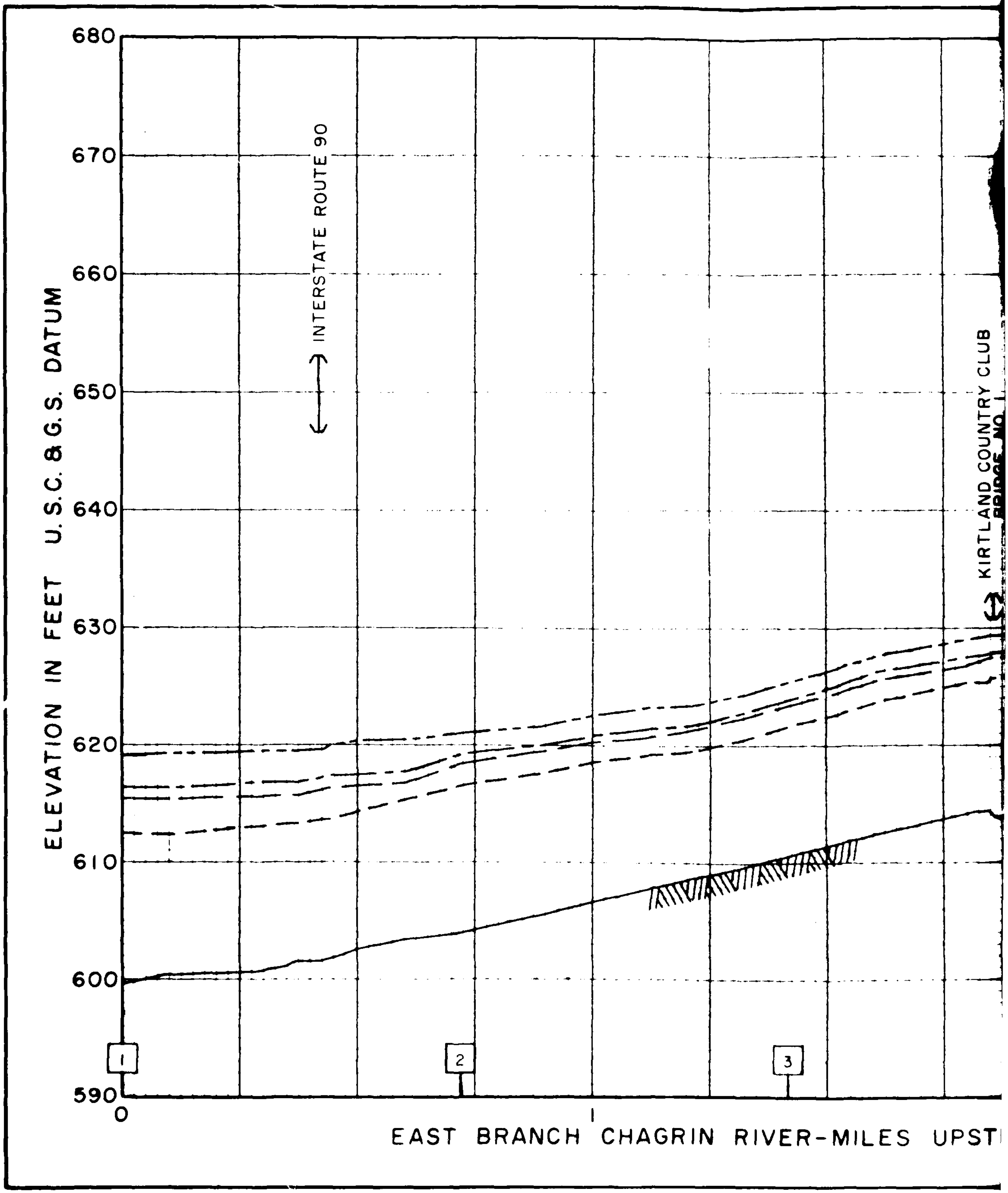
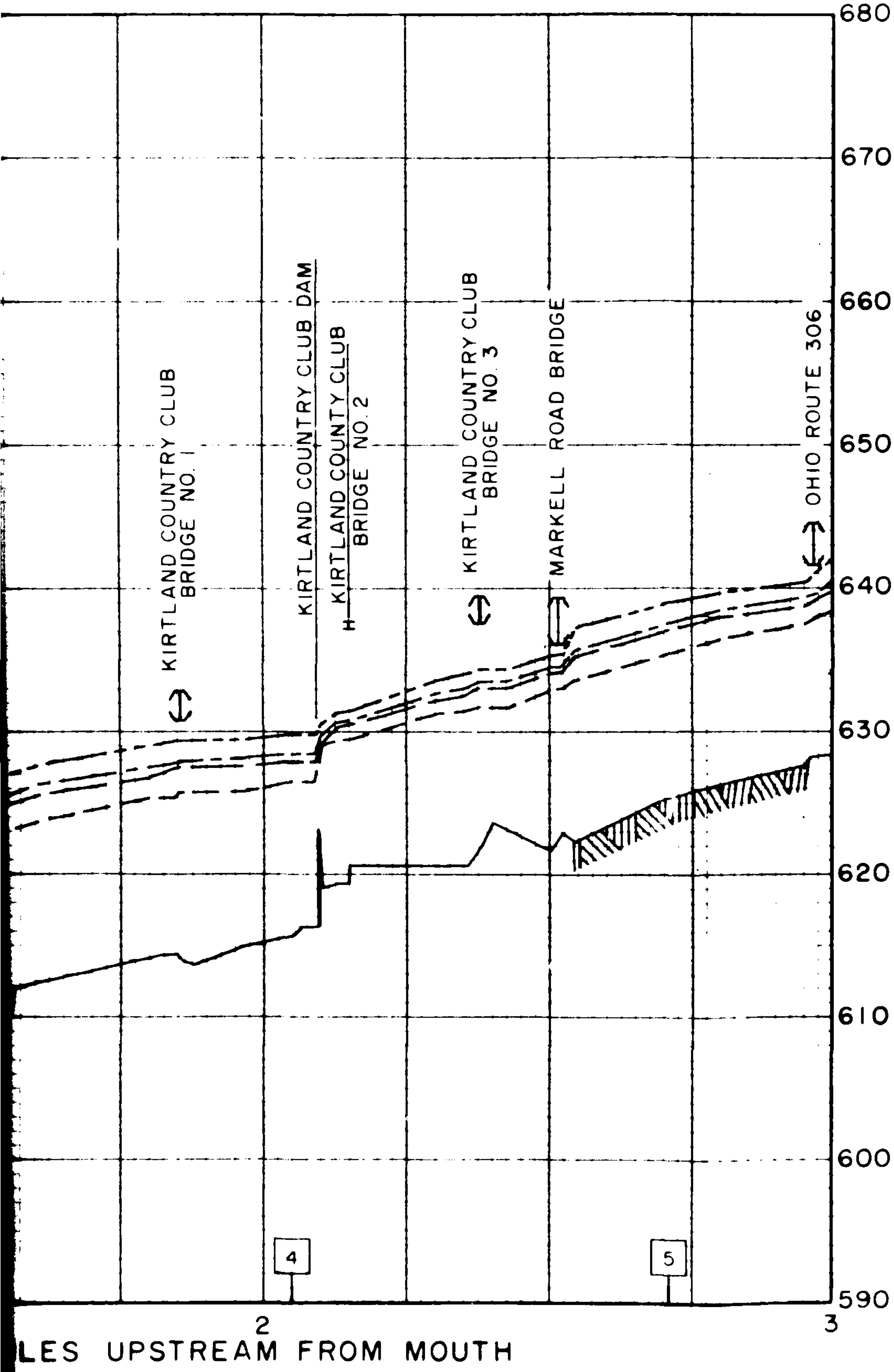
BUFFALO, NEW YORK

FLOOD PLAIN INFORMATION
LAKE AND GEAUGA COUNTIES, OHIO
EAST BRANCH CHAGRIN RIVER

FLOODED AREAS



680
670
660
650
640
630
620
610
600
590
ELEVATION IN FEET U.S.C.&G.S. DATUM
INTERSTATE ROUTE 90
KIRTLAND COUNTRY CLUB
BRIDGE NO. 1
1
2
3
0
1
EAST BRANCH CHAGRIN RIVER-MILES UPST



LEGEND:

YEAR
100 YEAR
YEAR
YEAR
APPROX
APPROXI
APPROXI
SEC

DEPARTMENT THE
BUFFALO PS O
BUFFALO NEW YO
FLOOD PLAIN INFOR
LAKE AND GEAUGA COU
EAST BRANCH CHAGR

FLOOD PROFIL

LEGEND:

500 YEAR FLOOD

100 YEAR FLOOD

50 YEAR FLOOD

10 YEAR FLOOD

APPROXIMATE BRIDGE FLOOR

APPROXIMATE LOW STEEL

APPROXIMATE STREAM BED

[2] CROSS SECTION

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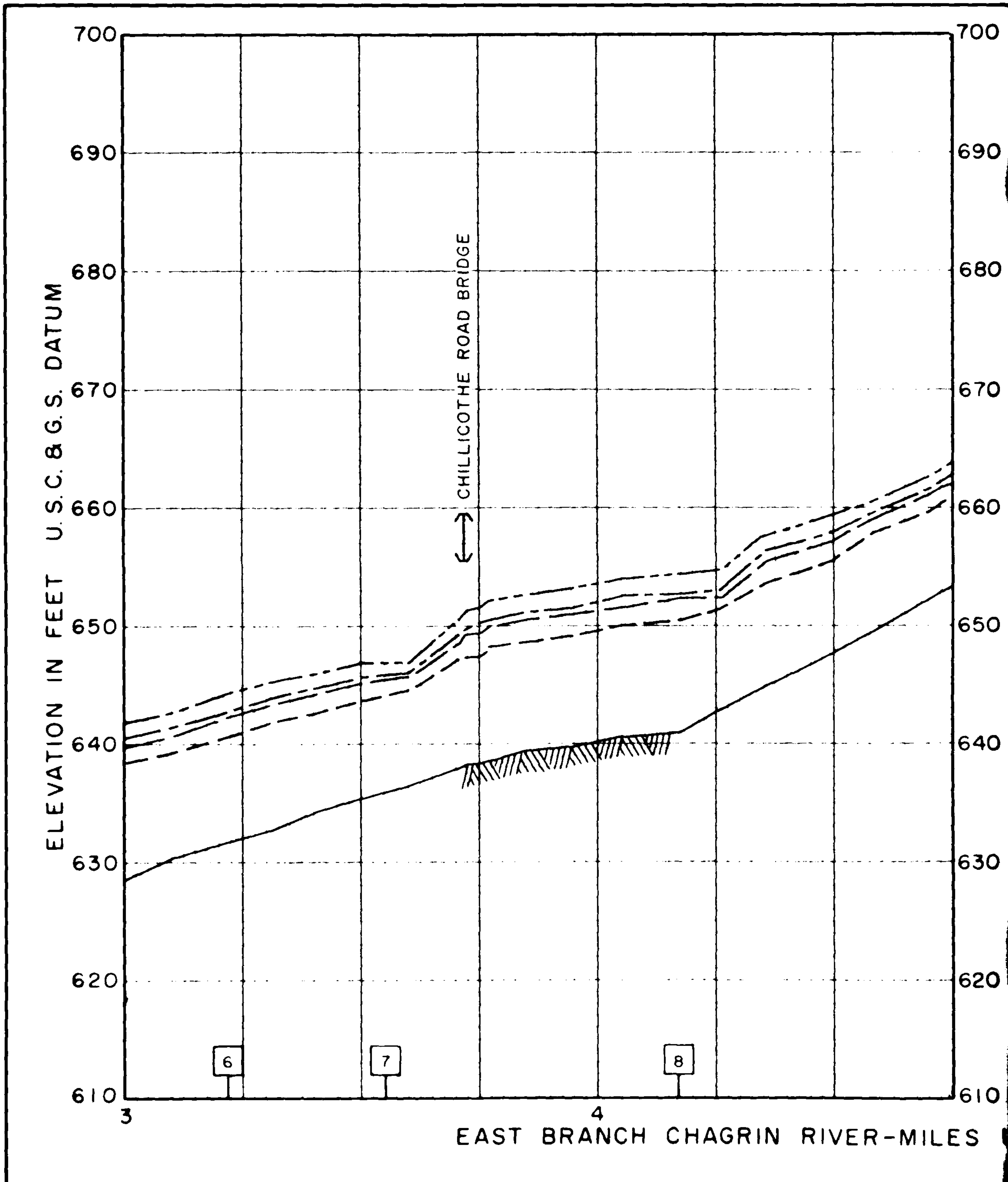
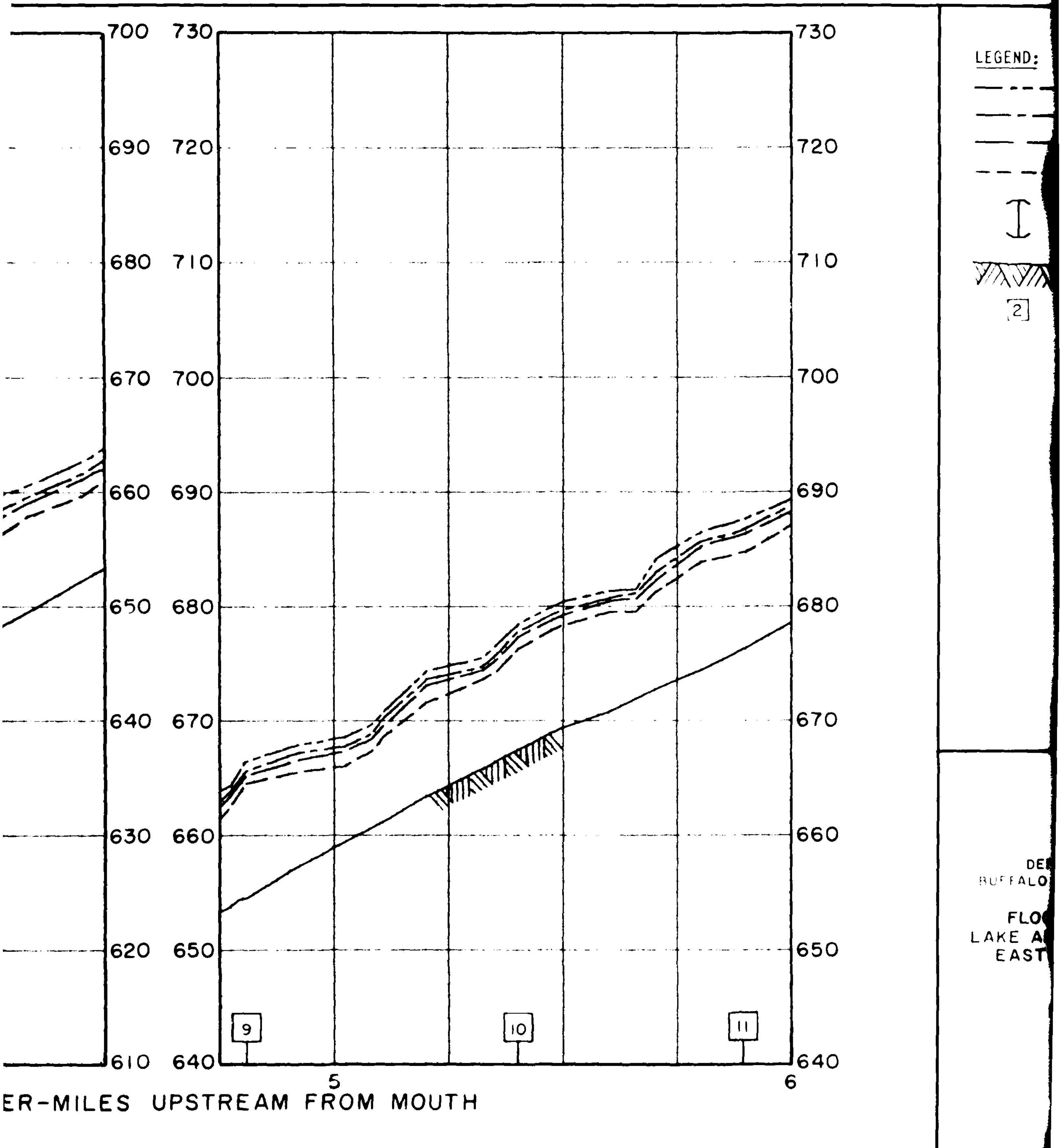
FLOOD PLAIN INFORMATION
LAKE AND GEAUGA COUNTIES, OHIO
EAST BRANCH CHAGRIN RIVER

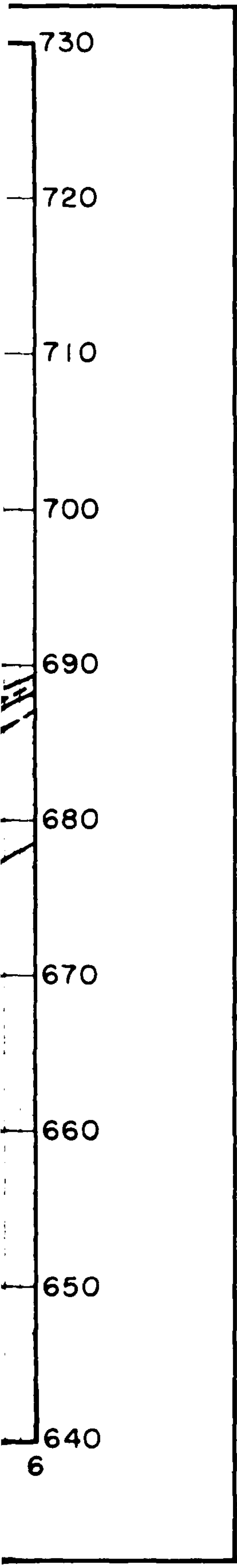
FLOOD PROFILES

PLATE 6



ELEVATION IN FEET U.S.C. & G.S. DATUM
700
690
680
670
660
650
640
630
620
610
CHILLICOTHE ROAD BRIDGE
6
7
8
3
4
EAST BRANCH CHAGRIN RIVER-MILES


700 690 680 670 660 650 640 630 620 610
730 720 710 700 690 680 670 660 650 640
9
10
11
5
6
ER-MILES UPSTREAM FROM MOUTH
LEGEND:
2
DE
BUFFALO
FLO
LAKE A
EAST



LEGEND:

- 500 YEAR FLOOD
- 100 YEAR FLOOD
- 50 YEAR FLOOD
- 10 YEAR FLOOD
- APPROXIMATE BRIDGE FLOOR
- APPROXIMATE LOW STEEL
- APPROXIMATE STREAM BED
- 2 CROSS SECTION

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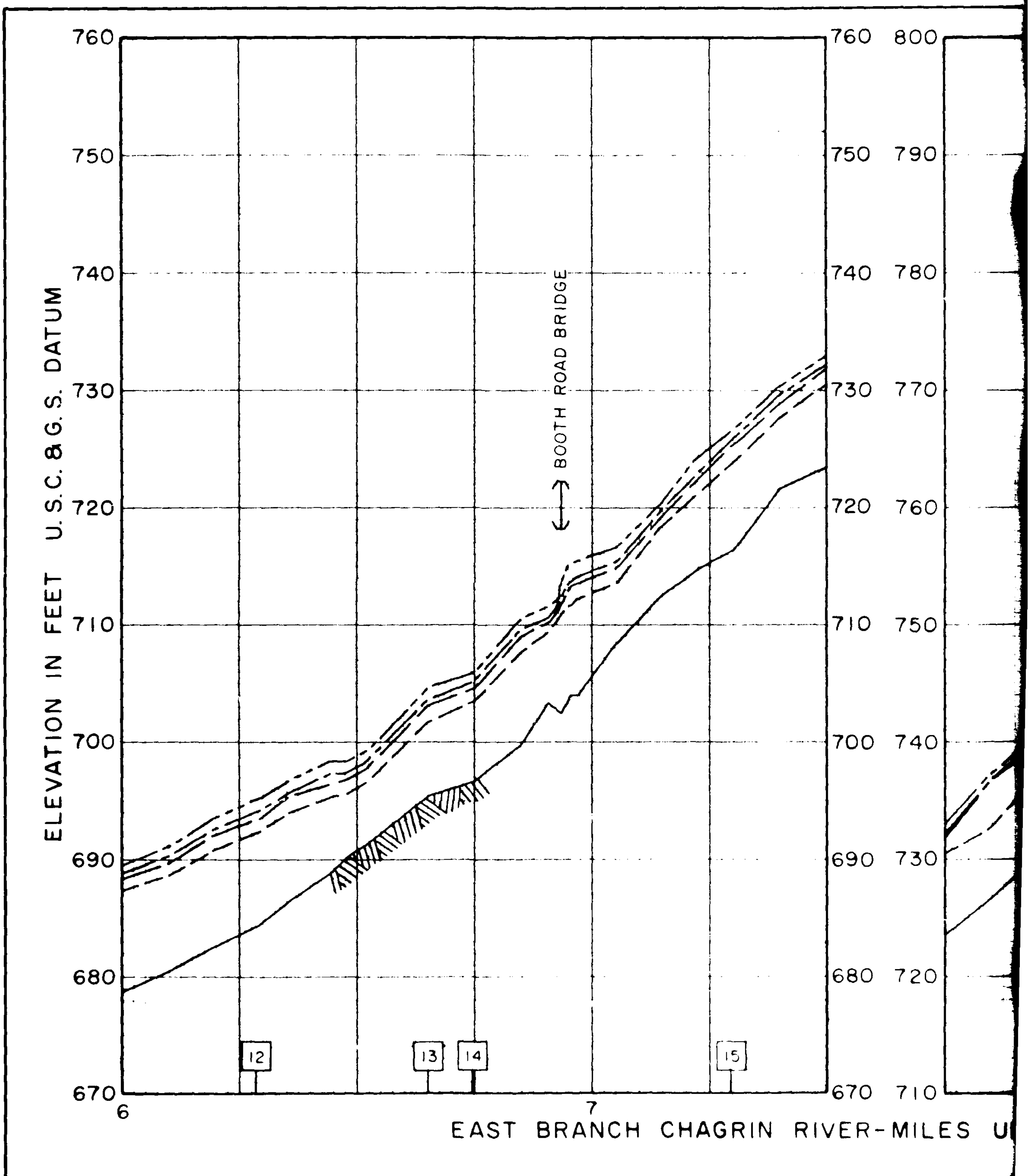
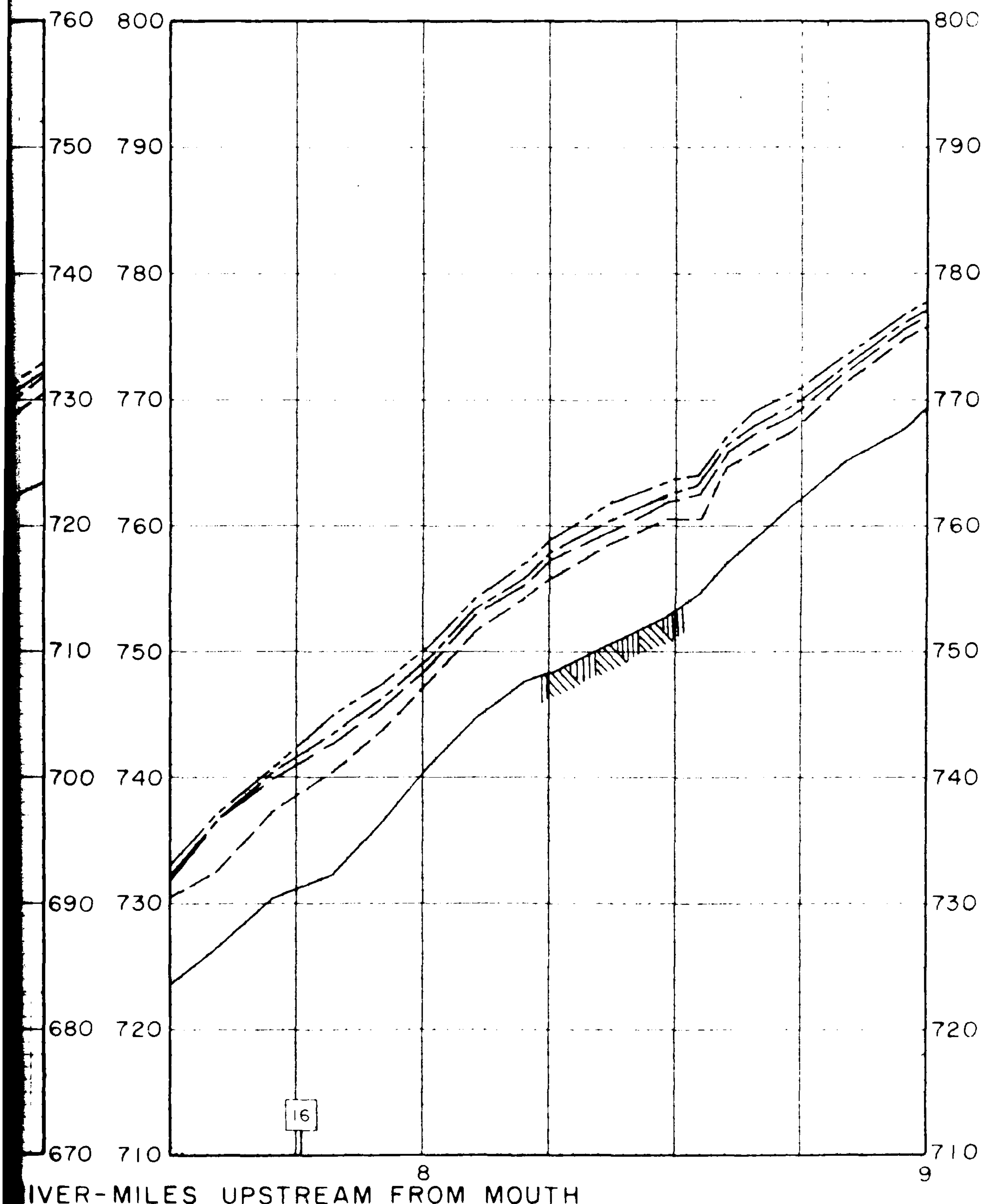
BUFFALO, NEW YORK

FLOOD PLAIN INFORMATION
LAKE AND GEAUGA COUNTIES, OHIO
EAST BRANCH CHAGRIN RIVER

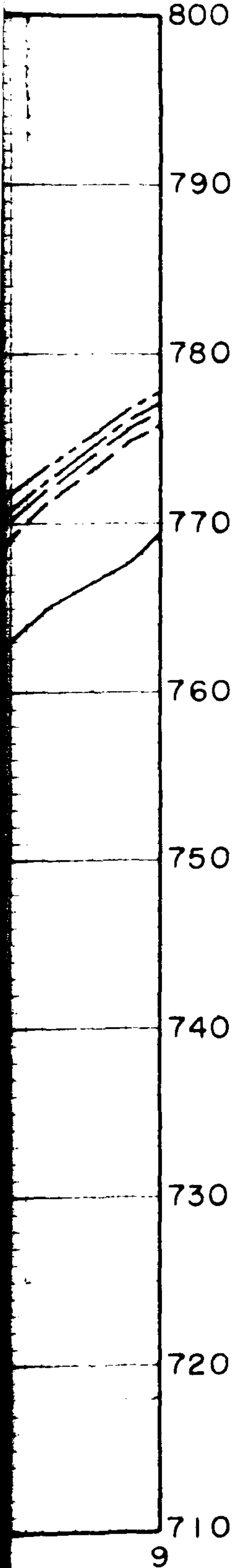
FLOOD PROFILES



ELEVATION IN FEET U.S.C.&G.S. DATUM
760
750
740
730
720
710
700
690
680
670
800
790
780
770
760
750
740
730
720
710
BOOTH ROAD BRIDGE
12
13
14
15
6
7
EAST BRANCH CHAGRIN RIVER-MILES U



760
750
740
730
720
710
700
690
680
670
800
790
780
770
760
750
740
730
720
710
16
8
9
IVER-MILES UPSTREAM FROM MOUTH



LEGEND:

500 YEAR FLOOD

100 YEAR FLOOD

50 YEAR FLOOD

10 YEAR FLOOD

APPROXIMATE BRIDGE FLOOR

APPROXIMATE LOW STEEL

APPROXIMATE STREAM BED

[2] CROSS SECTION

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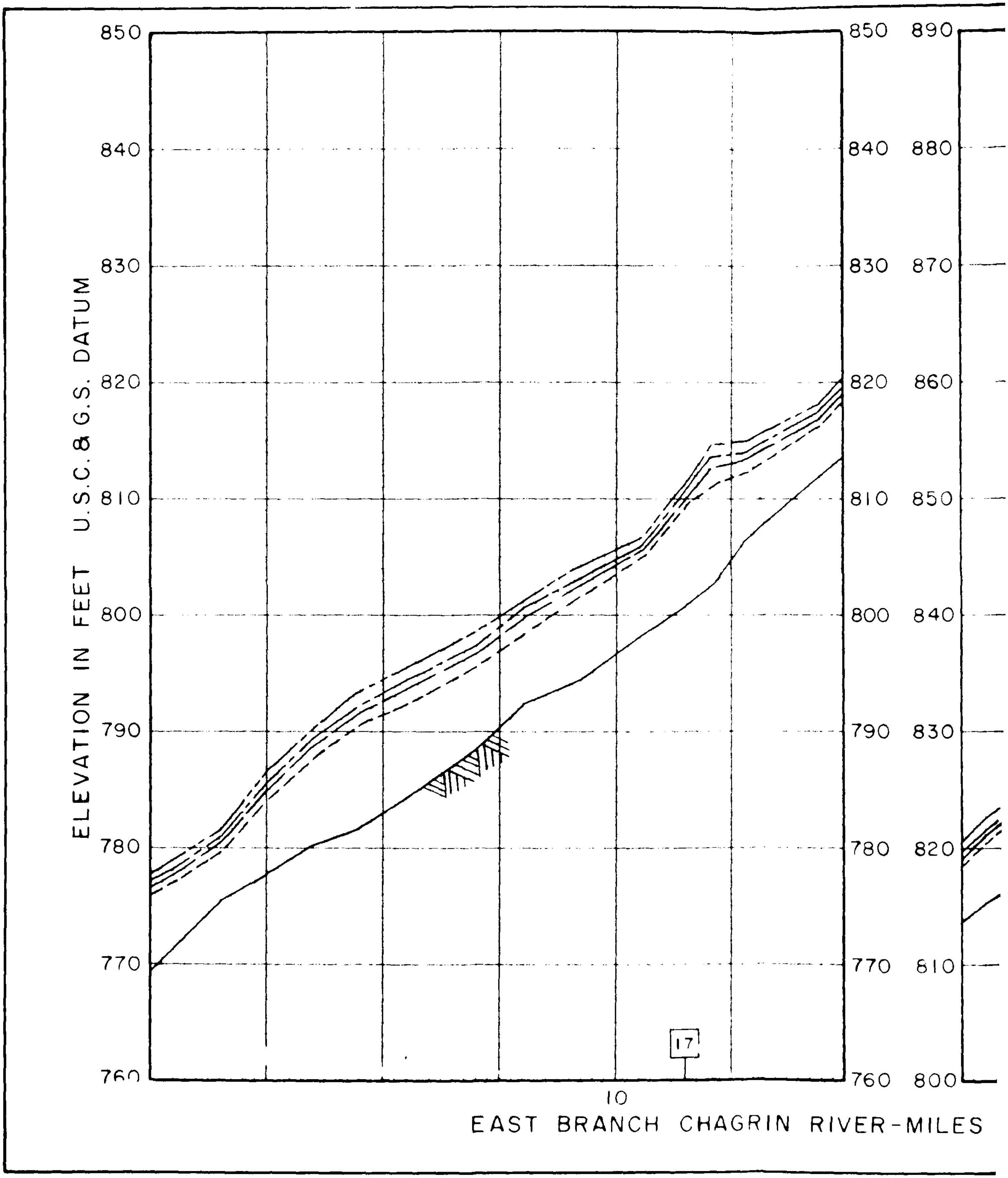
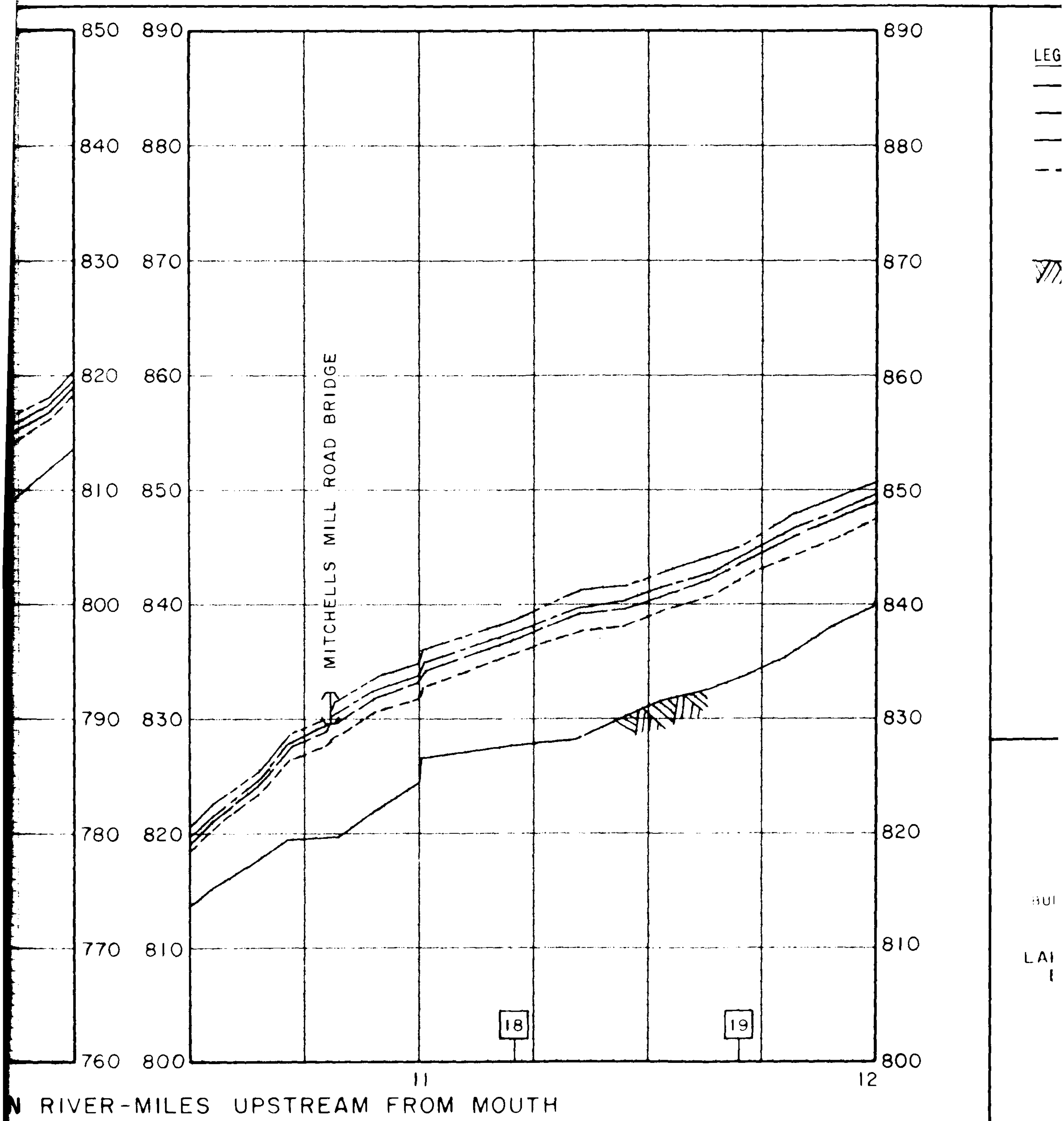
FLOOD PLAIN INFORMATION
LAKE AND GEAUGA COUNTIES, OHIO
EAST BRANCH CHAGRIN RIVER

FLOOD PROFILES

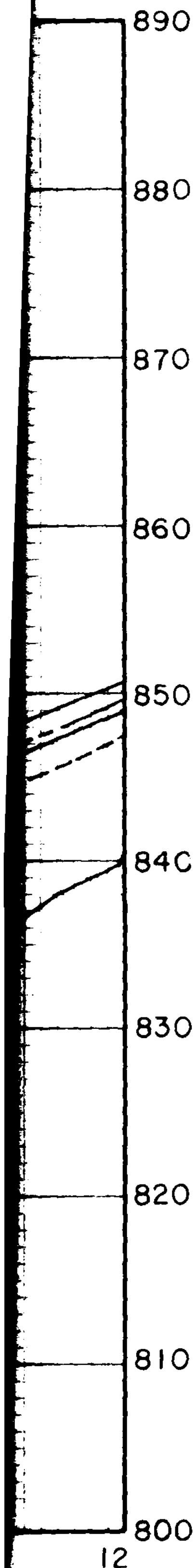
PLATE 8



ELEVATION IN FEET U.S.C.&G.S. DATUM
850
840
830
820
810
800
790
780
770
760
850
840
830
820
810
800
790
780
770
760
890
880
870
860
850
840
830
820
810
800
17
10
EAST BRANCH CHAGRIN RIVER-MILES



850 890
840 880
830 870
820 860
810 850
800 840
790 830
780 820
770 810
760 800
890
880
870
860
850
840
830
820
810
800
MITCHELLS MILL ROAD BRIDGE
18
19
11
12
N RIVER-MILES UPSTREAM FROM MOUTH
LEG



LEGEND:

500 YEAR FLOOD

100 YEAR FLOOD

50 YEAR FLOOD

10 YEAR FLOOD

APPROXIMATE BRIDGE FLOOR

APPROXIMATE LOW STEEL

APPROXIMATE STREAM BED

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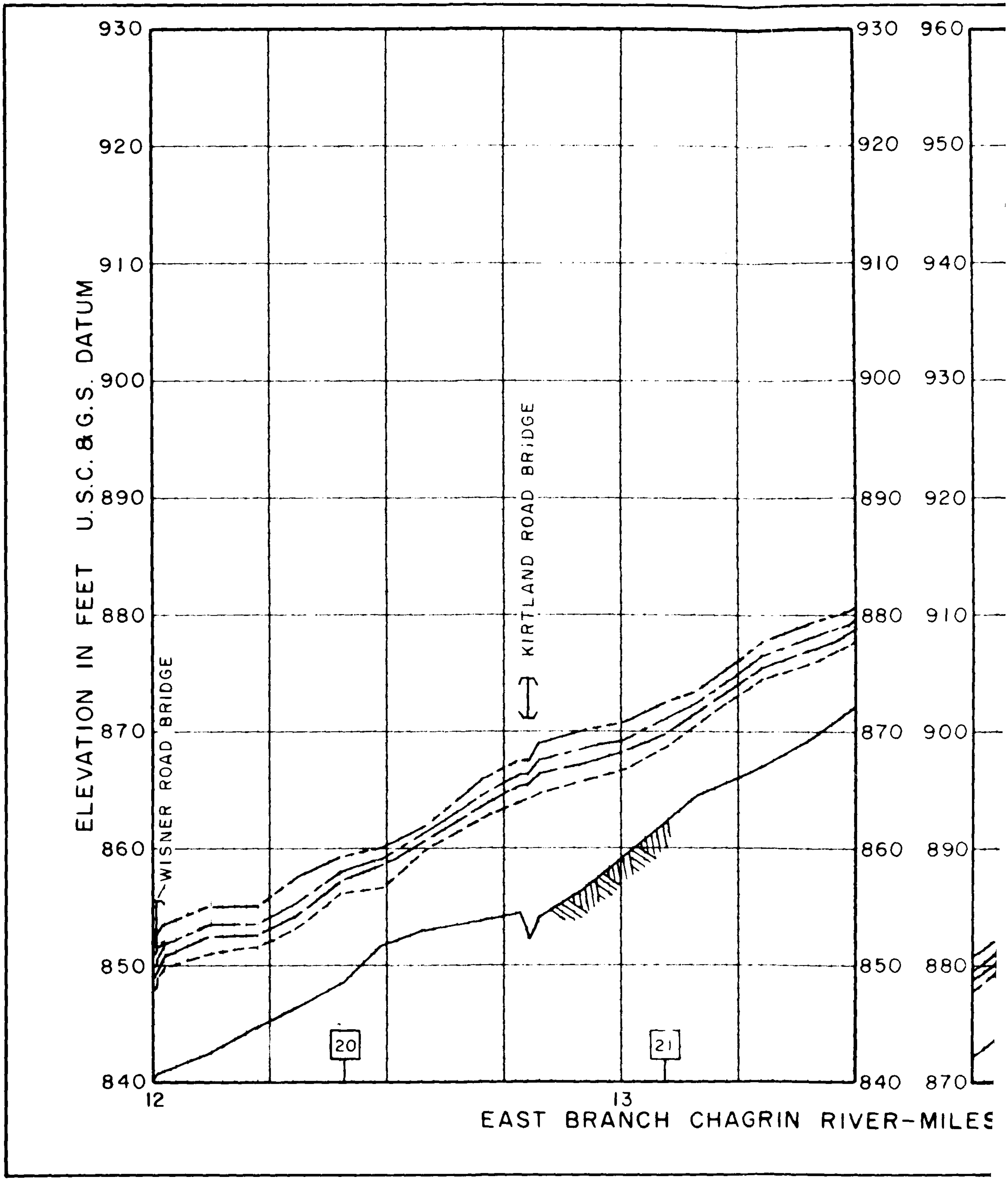
FLOOD PLAIN INFORMATION
LAKE AND GEAUGA COUNTIES, OHIO
EAST BRANCH CHAGRIN RIVER

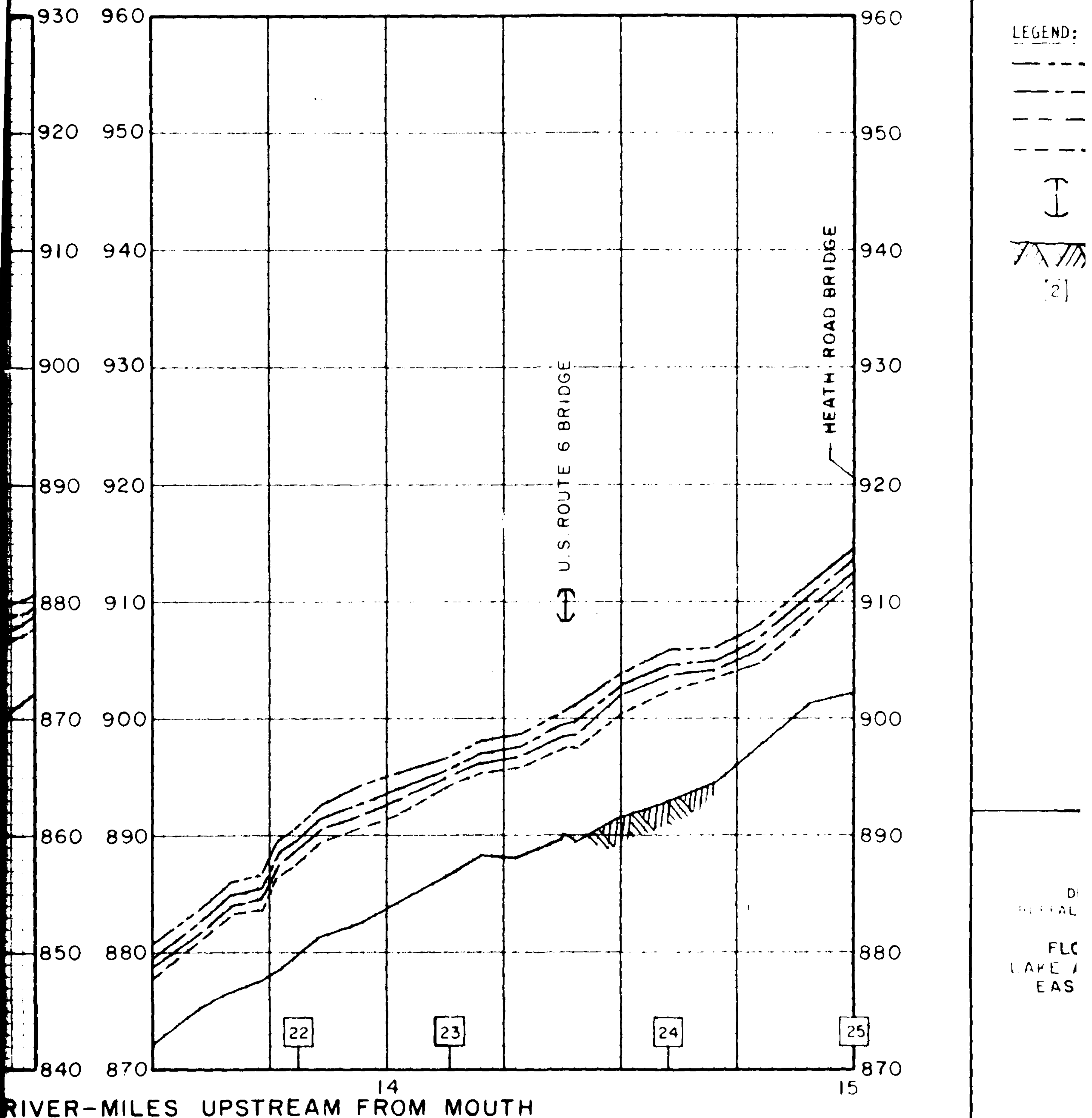
FLOOD PROFILES

JULY 1976

PLATE 9



930
920
910
900
890
880
870
860
850
840
930
920
910
900
890
880
870
860
850
840
960
950
940
930
920
910
900
890
880
870
ELEVATION IN FEET U.S.C.&G.S. DATUM
WISNER ROAD BRIDGE
KIRTLAND ROAD BRIDGE
20
21
12
13
EAST BRANCH CHAGRIN RIVER-MILES



930 920 910 900 890 880 870 860 850 840
960 950 940 930 920 910 900 890 880 870
U.S. ROUTE 6 BRIDGE
HEATH ROAD BRIDGE
22
23
24
25
14
15
RIVER-MILES UPSTREAM FROM MOUTH
LEGEND:
[2]
FLC
EAS

LEGEND:

500 YEAR FLOOD

100 YEAR FLOOD

50 YEAR FLOOD

10 YEAR FLOOD

APPROXIMATE BRIDGE FLOOR

APPROXIMATE LOW STEEL

APPROXIMATE STREAM BED

2 CROSS SECTION

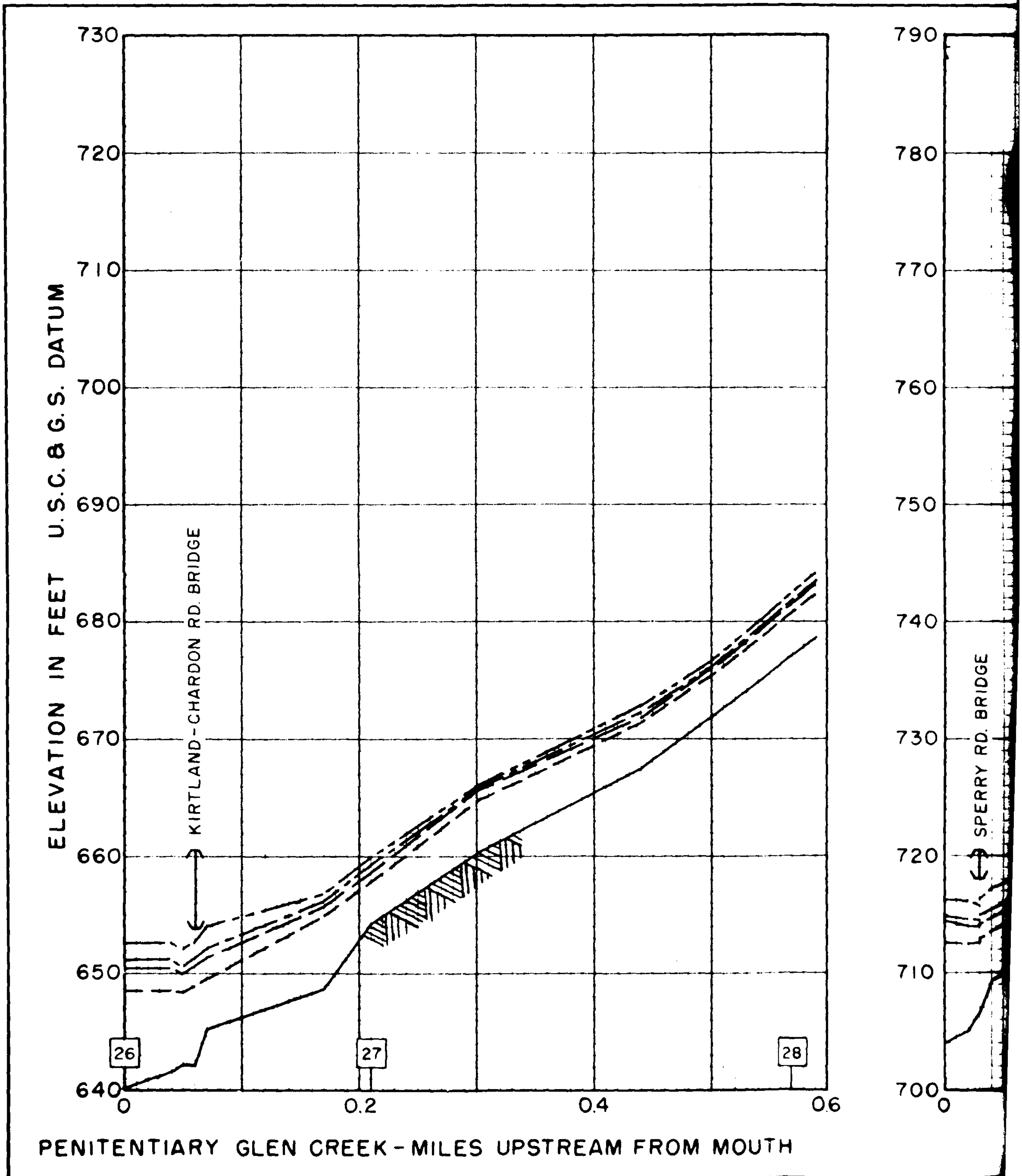
DEPARTMENT OF THE ARMY
BUFFALO DISTRICT, CORPS OF ENGINEERS
BUFFALO, NEW YORK

FLOOD PLAIN INFORMATION
LAKE AND GEAUGA COUNTIES, OHIO
EAST BRANCH CHAGRIN RIVER

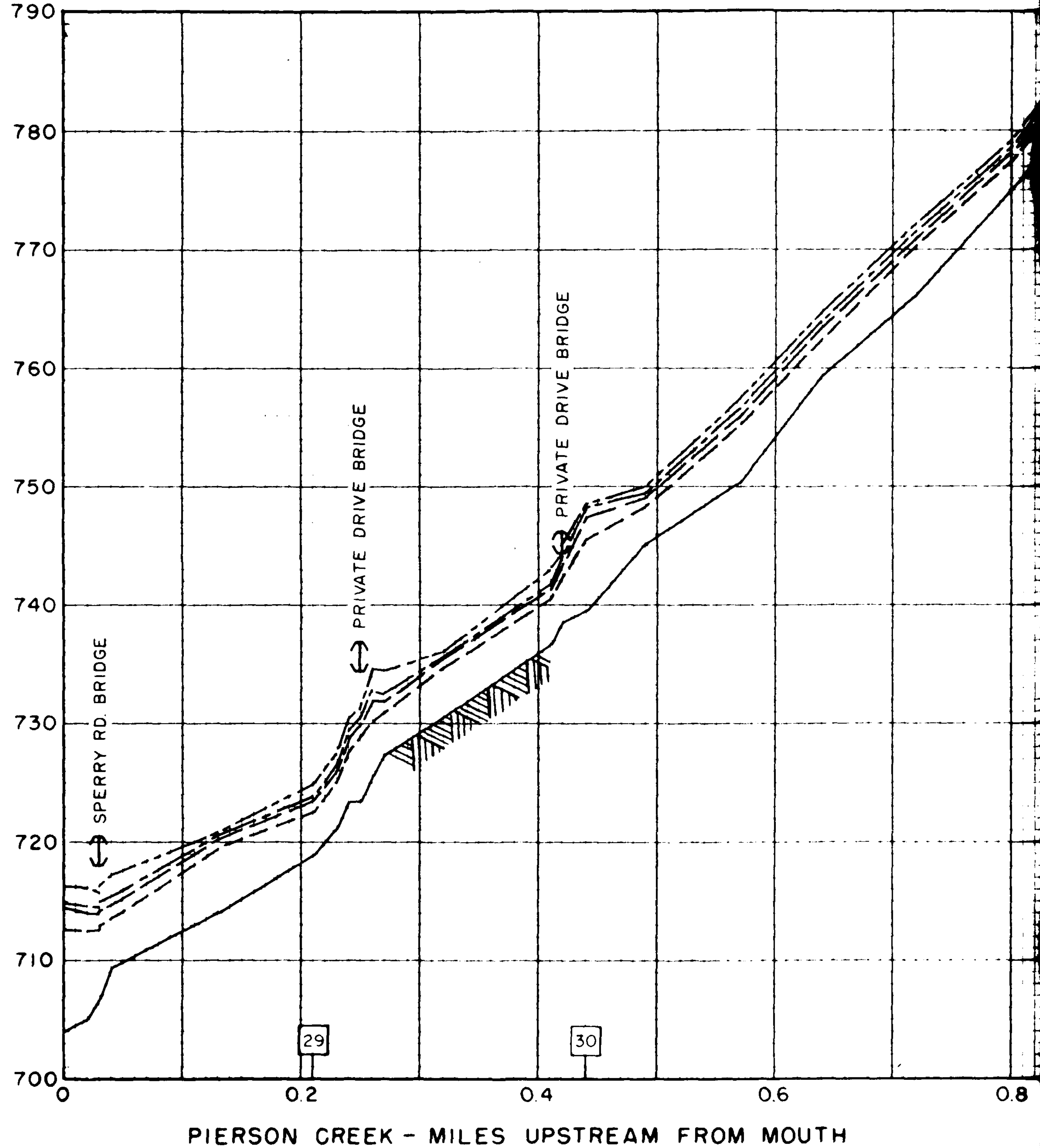
FLOOD PROFILES

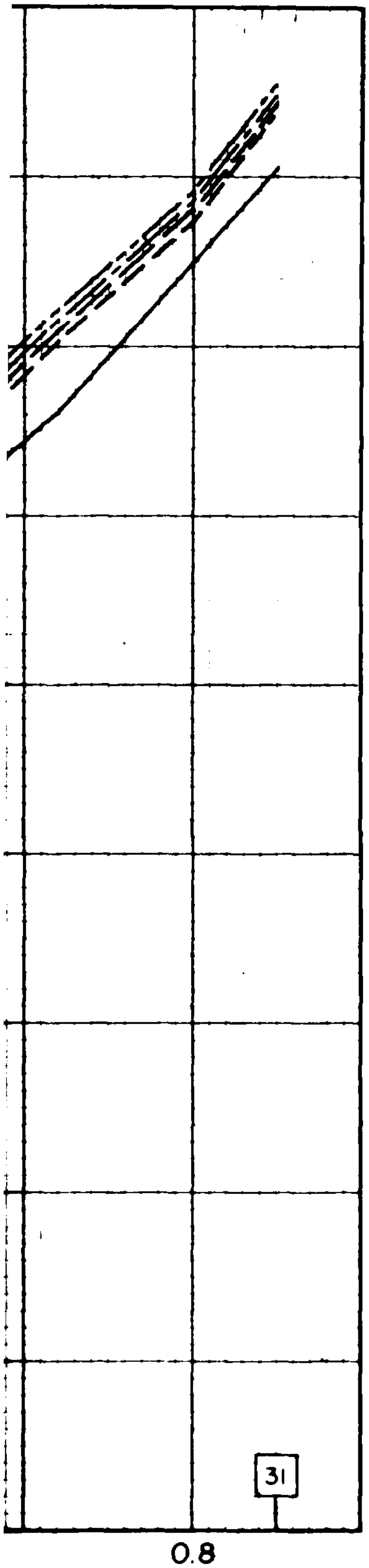
[illegible]

PLATE 10



ELEVATION IN FEET U.S.C.&G.S. DATUM
730
720
710
700
690
680
670
660
650
640
KIRTLAND-CHARDON RD. BRIDGE
26
27
28
0
0.2
0.4
0.6
PENITENTIARY GLEN CREEK-MILES UPSTREAM FROM MOUTH
790
780
770
760
750
740
730
720
710
700
SPERRY RD. BRIDGE
0


790
780
770
760
750
740
730
720
710
700
0
0.2
0.4
0.6
0.8
SPERRY RD. BRIDGE
PRIVATE DRIVE BRIDGE
PRIVATE DRIVE BRIDGE
29
30
PIERSON CREEK - MILES UPSTREAM FROM MOUTH



LEGEND:

500 YEAR FLOOD

100 YEAR FLOOD

50 YEAR FLOOD

10 YEAR FLOOD

APPROXIMATE BRIDGE FLOOR

APPROXIMATE LOW STEEL

APPROXIMATE STREAM BED

2 CROSS SECTION

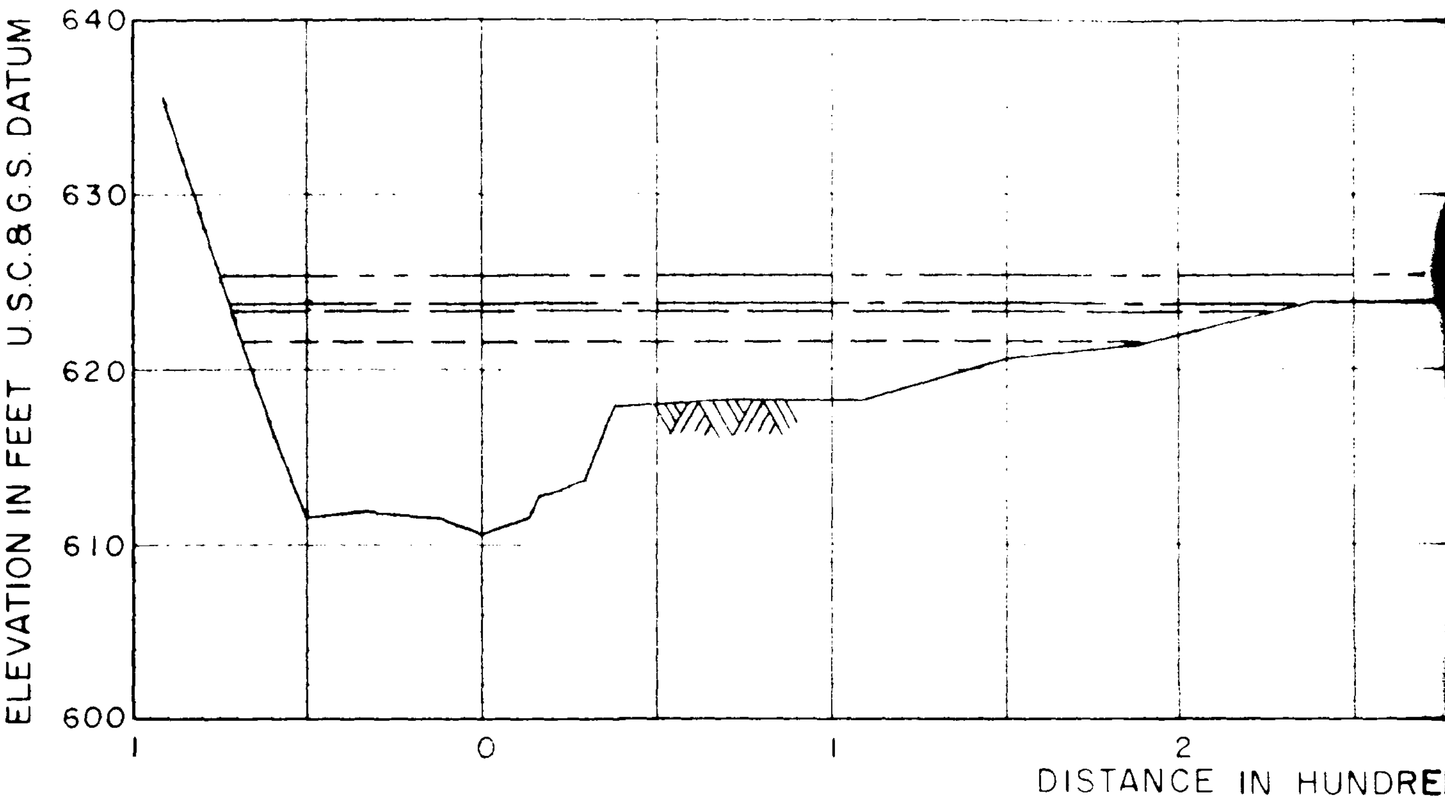
DEPARTMENT OF THE ARMY
BUFFALO DISTRICT, CORPS OF ENGINEERS
BUFFALO, NEW YORK

FLOOD PLAIN INFORMATION
LAKE AND GEAUGA COUNTIES, OHIO
EAST BRANCH CHAGRIN RIVER

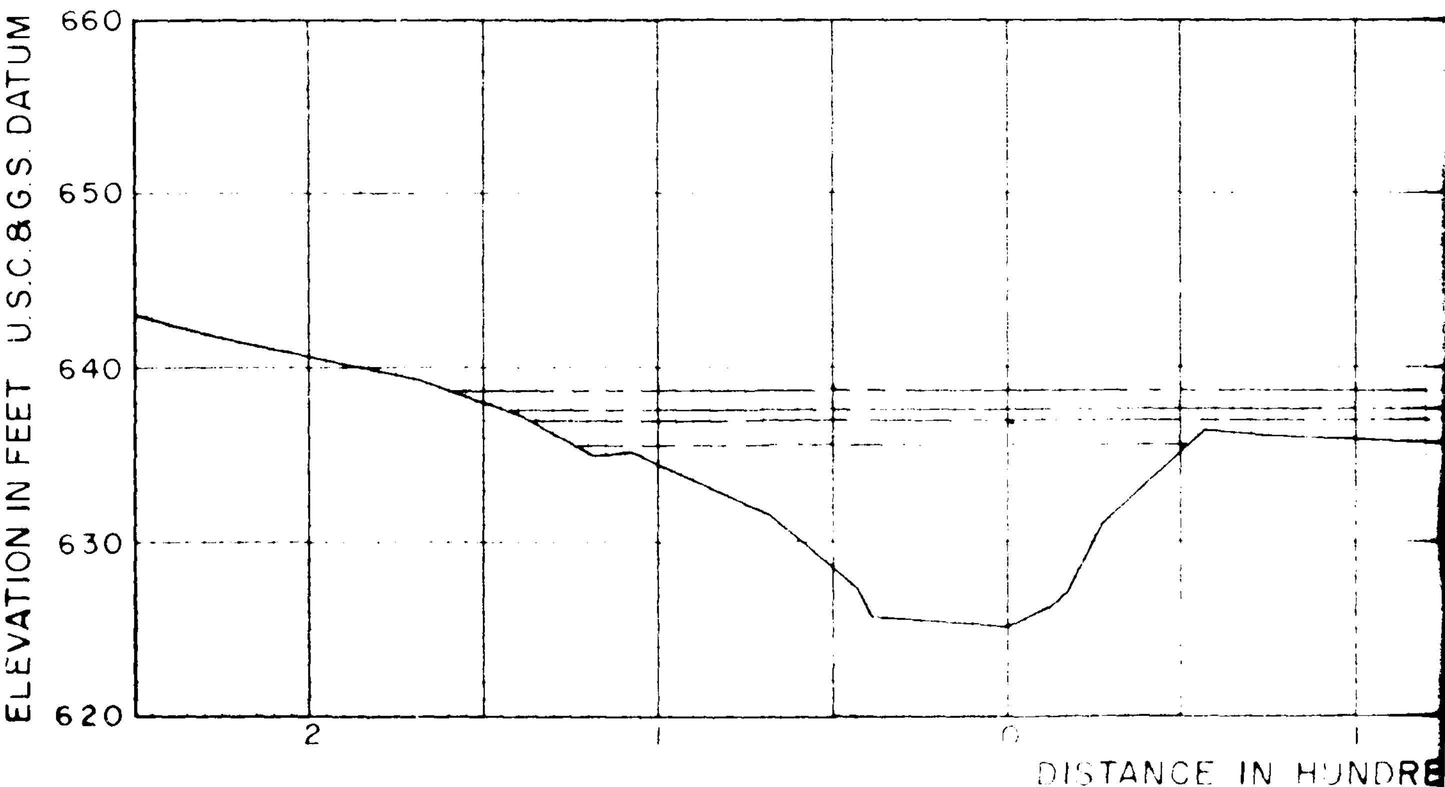
FLOOD PROFILES

JULY 1976

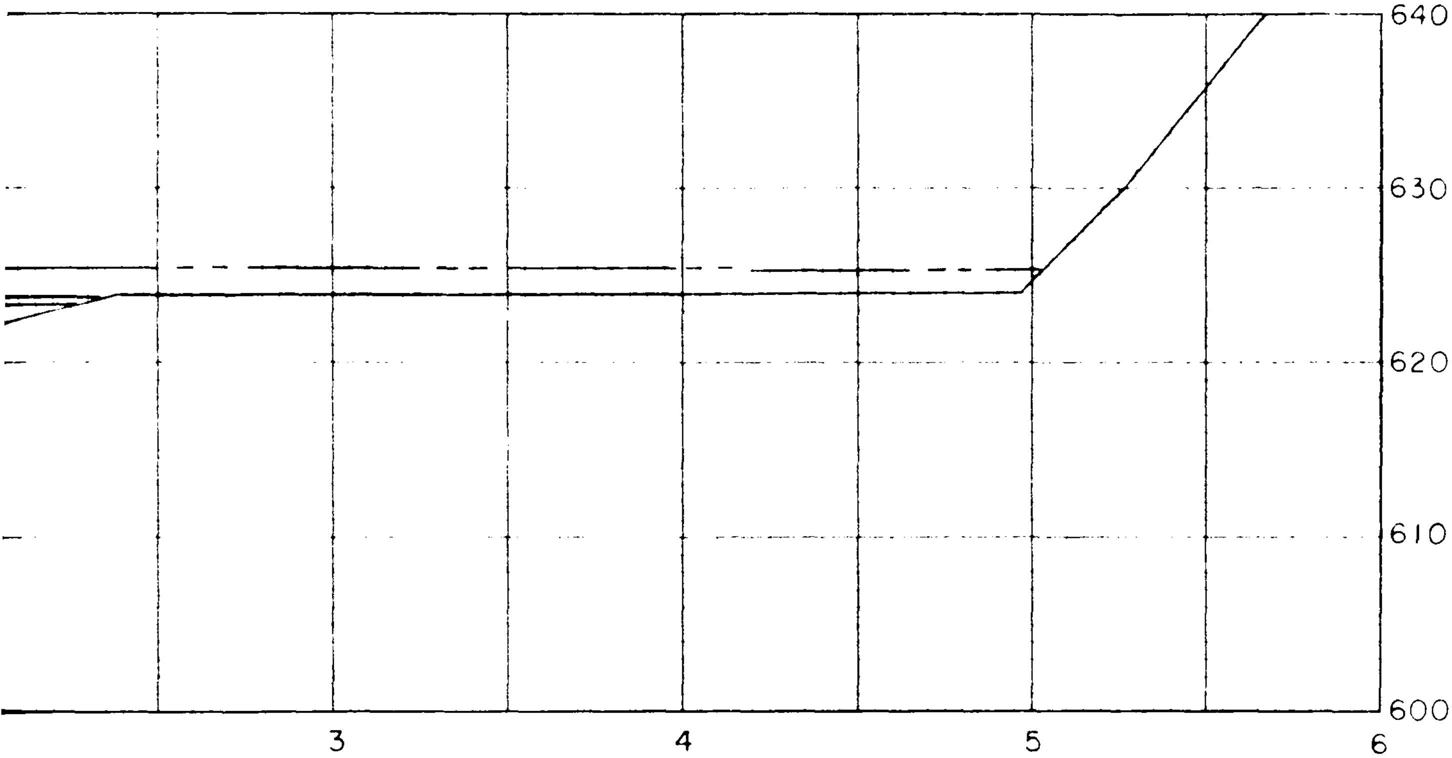
PLATE 11



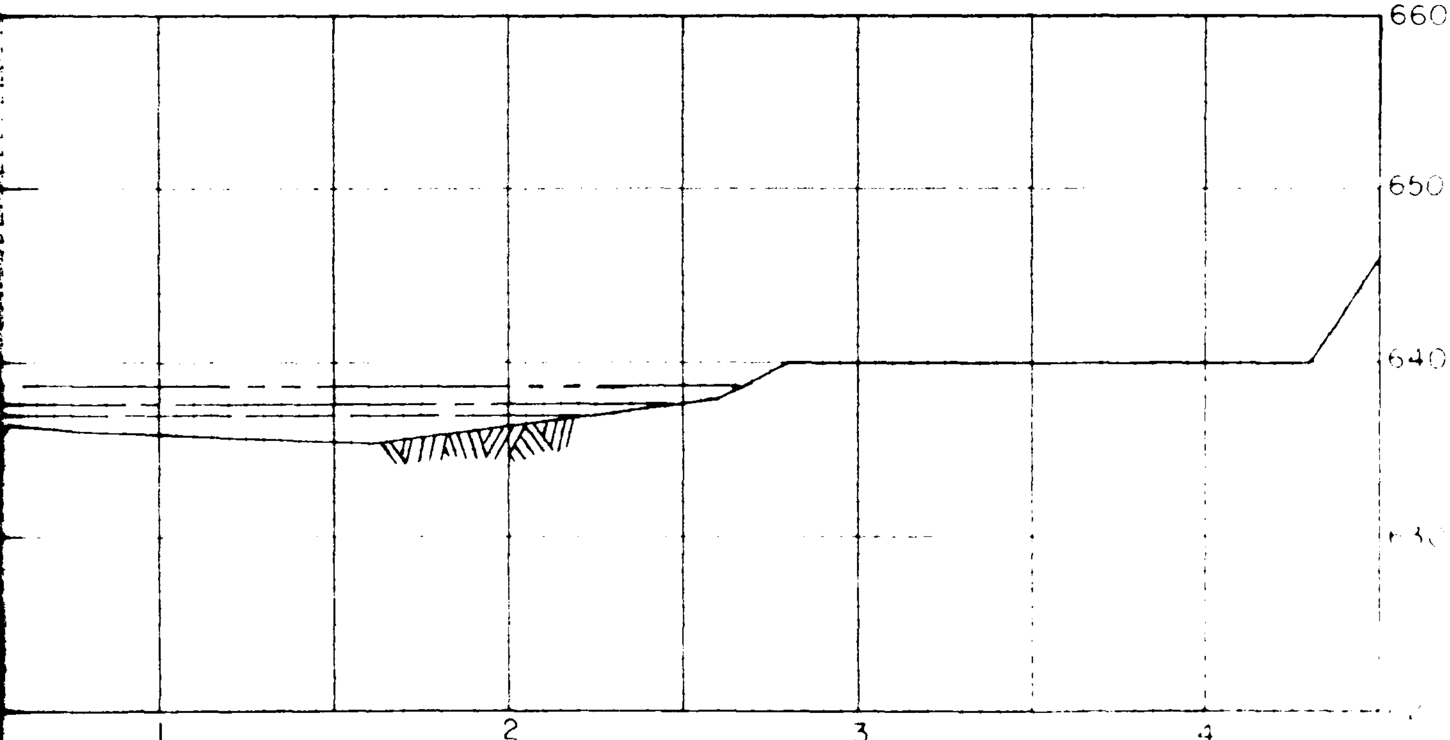
CROSS SECTION NO. 3



CROSS SECTION NO. 5



E IN HUNDREDS OF FEET
NO. 3 MILE POINT 1.42

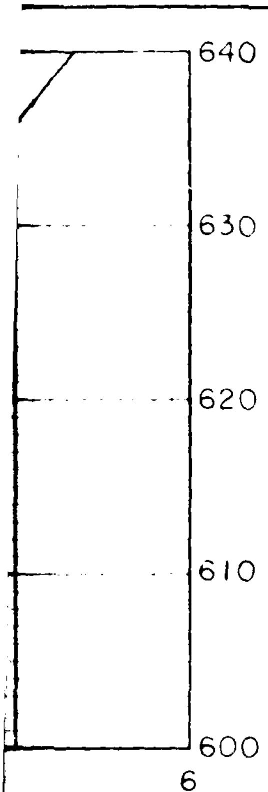


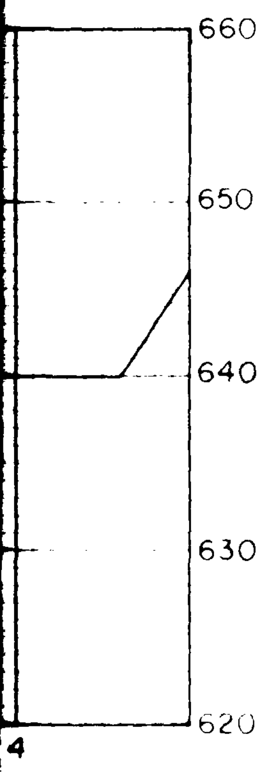
E IN HUNDREDS OF FEET
NO. 5 MILE POINT 2.71

LEGE

FL
AKE
EAS

VA





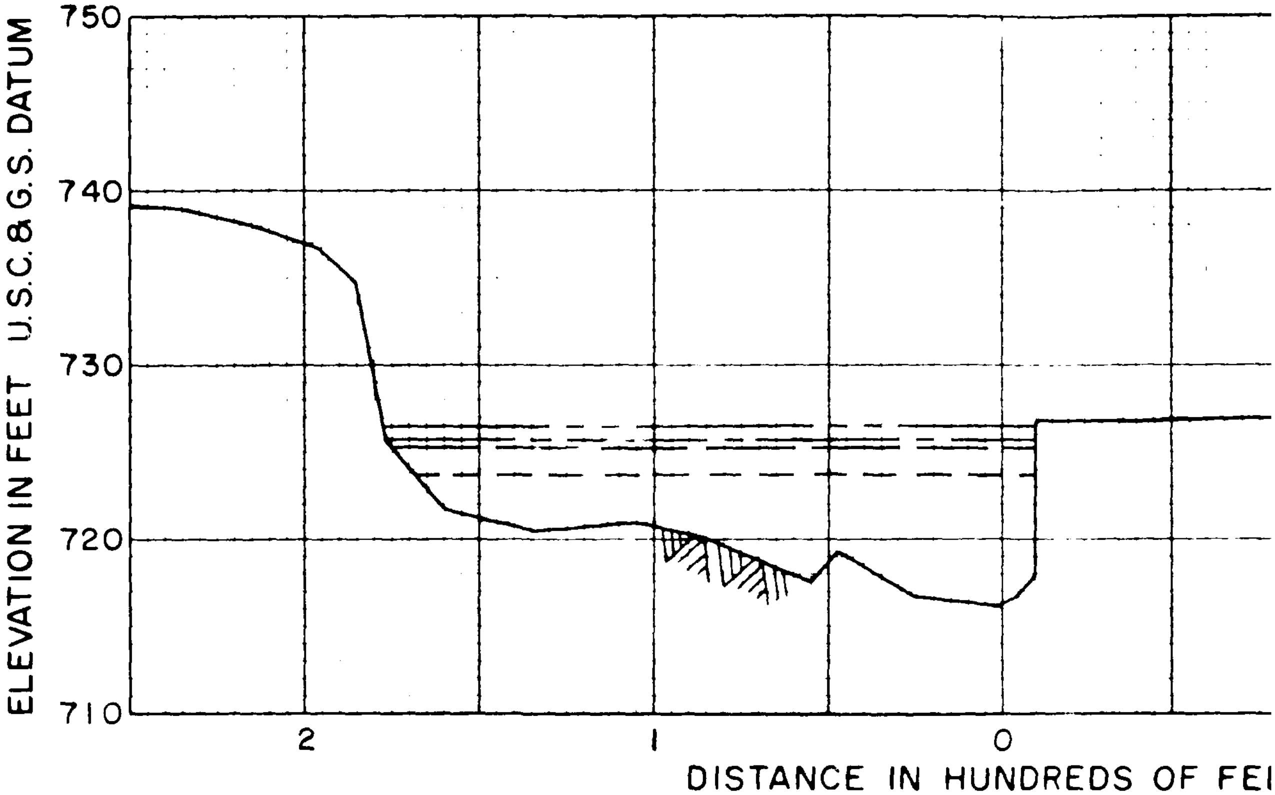
LEGEND:

	[illegible]0 YEAR FLOOD
	100 YEAR FLOOD
	[illegible]0 YEAR FLOOD
	[illegible]0 YEAR FLOOD
	APPROXIMATE BRIDGE FLOOR
	APPROXIMATE LOW STEEL
	APPROXIMATE STREAM BED

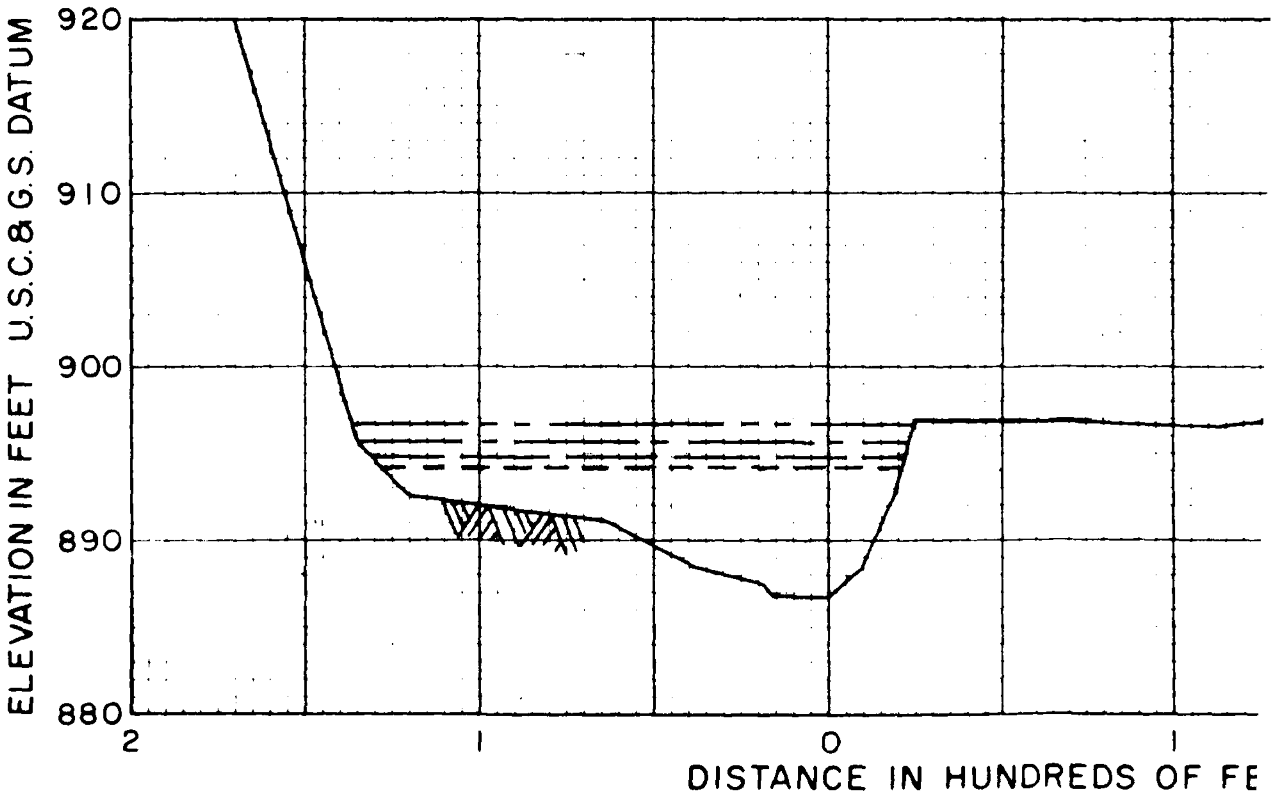
DEPARTMENT OF THE ARMY
[illegible] ENGINEERS
[illegible]

FLOOD PLAIN INFORMATION
LAKE AND GEAUGA COUNTIES, OHIO
EAST BRANCH CHAGRIN RIVER

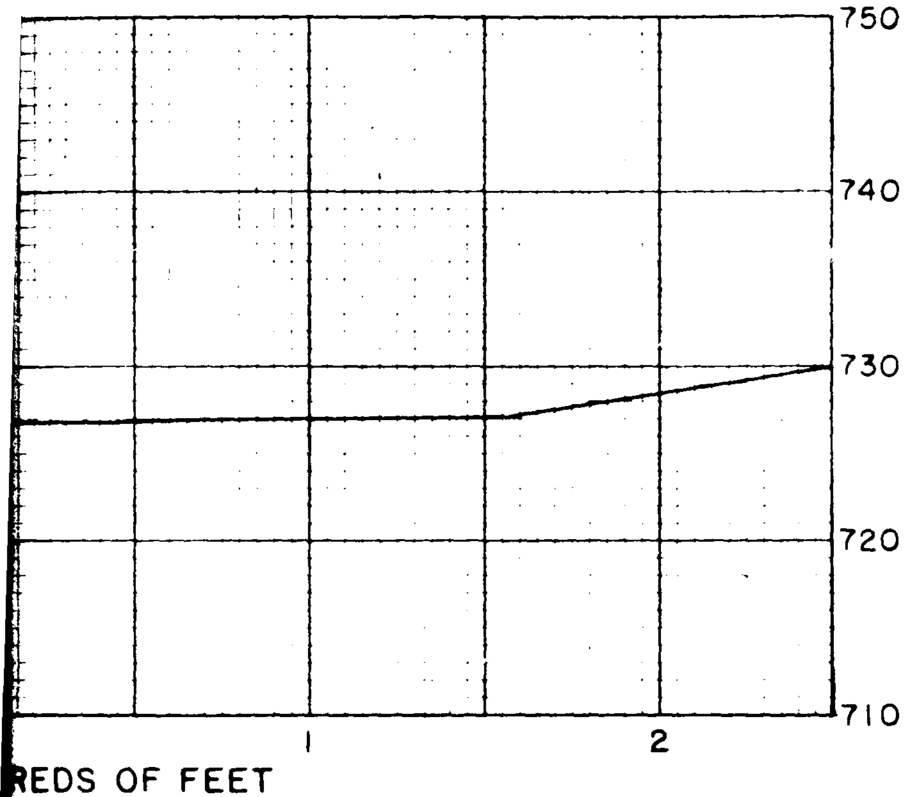
VALLEY CROSS SECTIONS



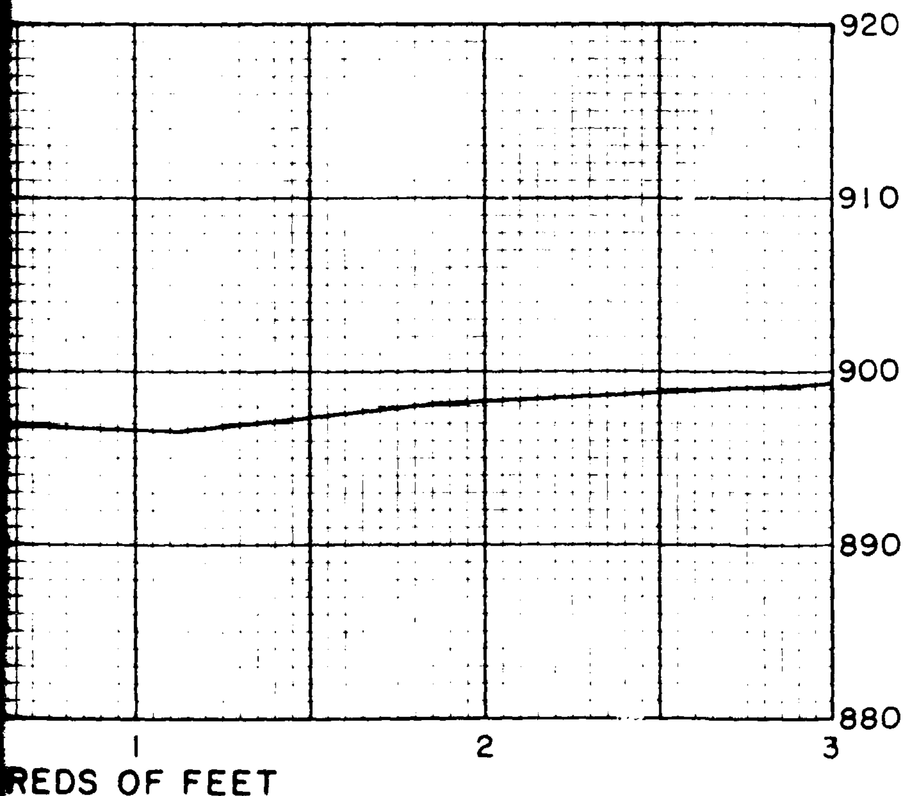
CROSS SECTION NO. 15 MILE



CROSS SECTION NO. 23 MILE



MILE POINT 7.29



MILE POINT 14.13

LEGEND:

500 YEAR FLOOD

100 YEAR FLOOD

50 YEAR FLOOD

10 YEAR FLOOD

APPROXIMATE BRIDGE FLOOR

APPROXIMATE LOW STEEL

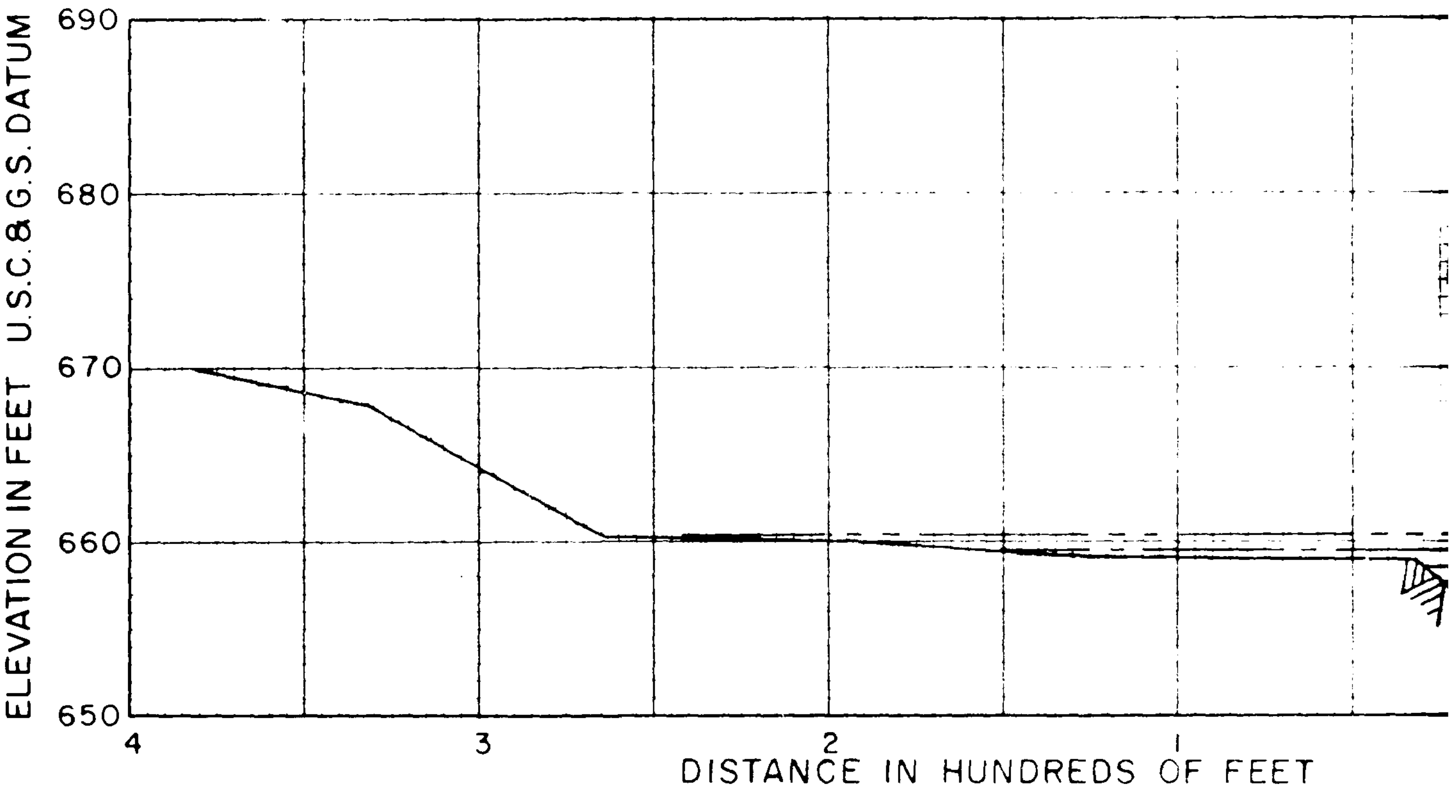
APPROXIMATE STREAM BED

DEPARTMENT OF THE ARMY
BUFFALO DISTRICT, CORPS OF ENGINEERS
BUFFALO, NEW YORK

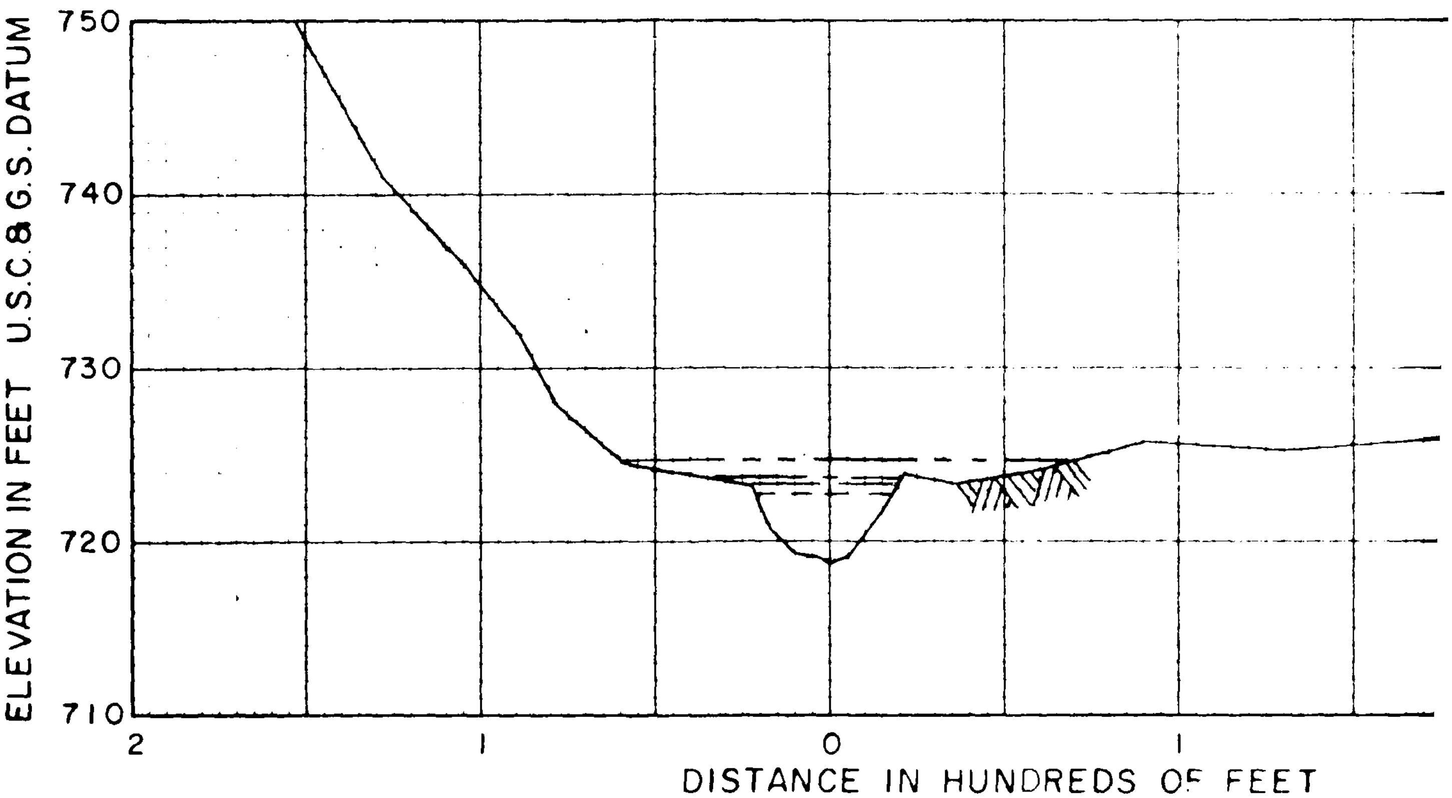
FLOOD PLAIN INFORMATION
LAKE AND GEAUGA COUNTIES, OHIO
EAST BRANCH CHAGRIN RIVER

VALLEY CROSS SECTIONS

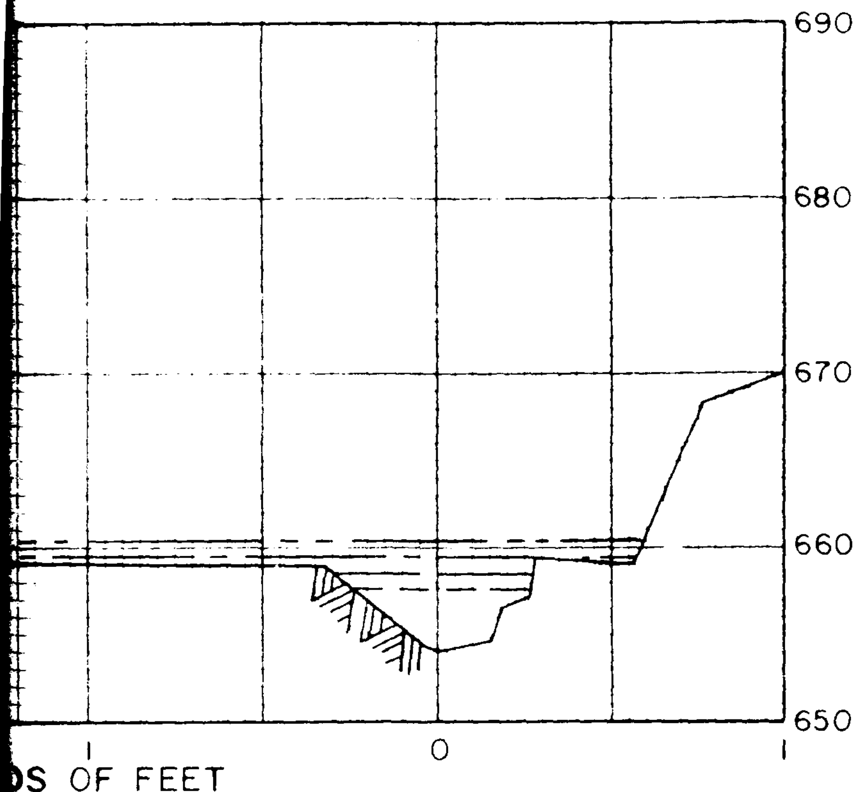
JULY 1976



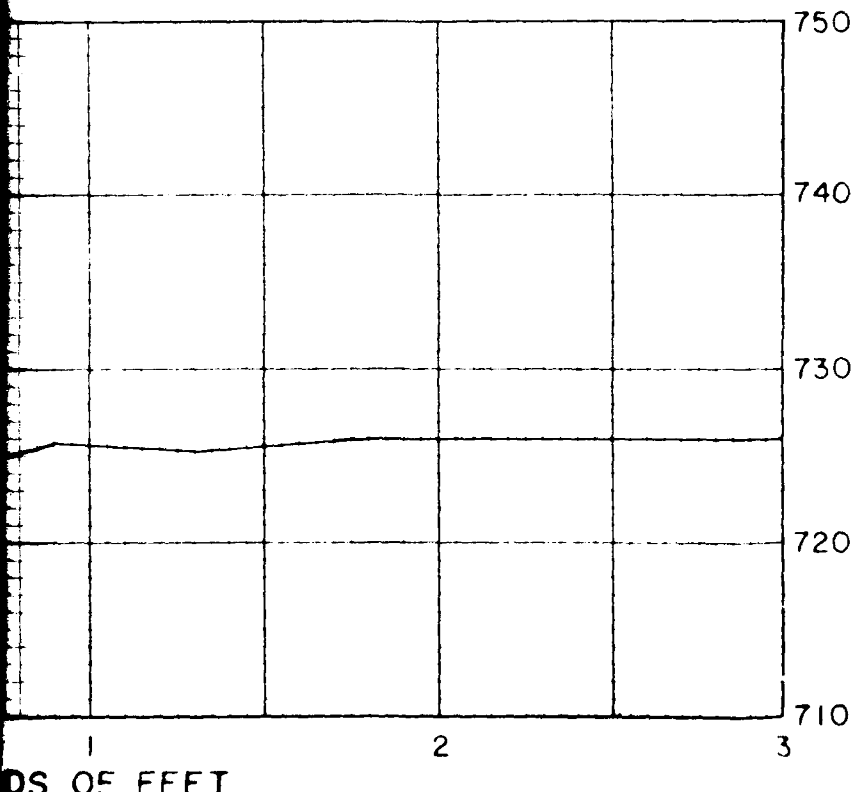
PENITENTIARY GLEN CREEK CROSS SECTION NO. 27



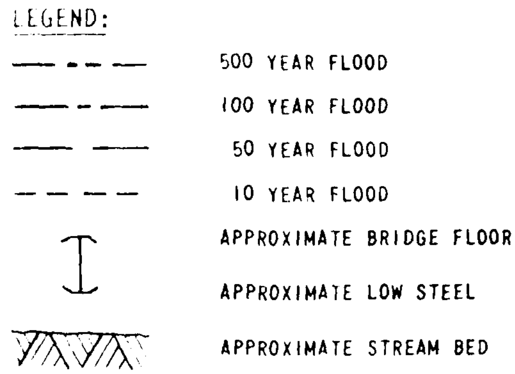
PIERSON CREEK CROSS SECTION NO. 31 MI



TION NO. 27 MILE POINT 0.21



NO. 31 MILE POINT 0.85



DEPARTMENT OF THE ARMY
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BUFFALO, NEW YORK

FLOOD PLAIN INFORMATION
LAKE AND GEAUGA COUNTIES, OHIO
EAST BRANCH CHAGRIN RIVER

VALLEY CROSS SECTIONS

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PLATE 14